Sacramento-San Joaquin River Delta — Table of Contents

Tables

Figures

Sacramento-San Joaquin River Delta

Current State of the Region

Purpose of Overlay Area

Some areas of the state with common water issues or interests often cross the boundaries from one hydrologic region to another. California Water Plan (CWP) Update 2005 was the first water plan update in the Bulletin 160 series to describe overlay areas. An overlay area is an area of special interest that has common water issues or interests that encompasses multiple hydrologic regions. DWR defines an overlay area as an area of: (1) statewide significance where water management strategies and actions in the area affect much of the remainder of the state; and (2) common water management conditions, issues, and integrated water planning opportunities that spans more than one of the 10 hydrologic regions. The two overlay areas of special interest are the Sacramento-San Joaquin Delta (Delta) and Mountain Counties.

For Update 2005, the Delta was included as an overlay area because of its common characteristics, environmental significance, and the important role it has in the State's water systems. The Delta encompasses about 740,000 acres of tidal influenced land near the confluence of the Sacramento and San Joaquin Rivers, and occupies portions of the Sacramento, San Joaquin, and San Francisco hydrologic regions. The geographic extent of the Delta overlay coincides with the statutory Delta Boundary that defines the Legal Delta (Water Code Section 12220).

Statewide Significance of the Delta

The Sacramento-San Joaquin Delta (the Delta) and Suisun Marsh are at the confluence of the Sacramento River and San Joaquin River basins, which drain about 40 percent of California. The Delta covers about 1,315 square miles (Figure D-1) in portions of six California counties and is part of the largest estuary on the West Coast of the United States. Covering only about 1 percent of California's area, the Delta contributes much more to the state than one might expect from its size.

PLACEHOLDER Figure D-1 Sacramento-San Joaquin Delta and Suisun Marsh

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

The Delta serves as a hub for California's two largest water systems in the state, the federal Central Valley Project (CVP) and the State Water Project (SWP). A large part of the state is dependent upon water exported from the Delta to meet much of its agricultural and urban needs. Approximately two-thirds of the state's population live and work in urban areas that receive at least some of their water supply from the Delta. About 3 million acres of agricultural land are irrigated with exported water. In addition to providing water for farms, homes, and industry, water exported from the Delta provides significant water supplies to California's vital wetlands. Water from the Delta's watershed is also used within various areas upstream of the Delta and exported to areas around the State without going through the Delta.

The Delta region is also important to the state because of its vital transportation and water conveyance facilities, ecosystem functions, and wide range of recreational opportunities. The Delta contains

highways, railroads and shipping routes, natural gas storage and transmission facilities, electric transmission pathways, and gasoline product distribution pipelines. Eighty percent of the state's commercial fishery species live in or migrate through the Delta. In addition, the Delta provides world renowned boating, hunting, fishing, and nature viewing opportunities, with 12 million user-days annually.

From a flooding viewpoint at least 75 percent of the Delta Area, more than 78 percent of its cropland, and over 210,000 people are exposed to a 500-year flood event. In addition, a catastrophic-level failure in the Sacramento-San Joaquin Delta would endanger a major source of water supply for 60 percent of California residents and for a portion of the state's vital agricultural industry. Major issues related to flood management facing the Delta are the impacts of climate change, subsidence, levee maintenance and certification, and impacts of development. Major floods occur regularly in the Sacramento-San Joaquin Delta Area. Some urban and small-stream flooding occurs in every large storm. Floods during winter storms that cause high water surface elevations and have strong winds have been a common cause of levee failures in the Delta. For example, the flows of the Sacramento River at Rio Vista during winter and early spring are often 30 times the typical late-summer flows. High water in the Delta can overtop levees, as well as increase the hydrostatic pressure on levees and their foundations, causing instability and increasing the risk of failure due to through-levee and/or under-levee seepage.

Delta levee failures have caused more than 170 inundations of islands and tracts since 1900. Levee failures will continue to occur, but the occurrences will be variable, as indicated by many factors. Tides and water-level surges due to low atmospheric pressure will contribute to high water levels at times, which may or may not coincide with periods of high Delta inflow caused by floods. Some inflow floods will have high contributions from the Mokelumne, Cosumnes, San Joaquin, or other smaller tributaries and other contributions will be primarily from the Sacramento River. In addition, isolated sunny-day levee failures (like that on the Upper Jones Tract in June 2004) will occur. These failures could be caused by burrowing activities that compromised the integrity of the levees.

Floods have been recorded in Central Valley for more than 175 years. The most notable flood in the nineteenth century was the "Great Flood" of 1861-1862. Central Valley floods of 1907 and 1909 revised flood management plans of the time and led to development of the San Joaquin River flood management system.

Table D-1 provides an itemization of islands and tracts flooded since 1900. The data, however, do not identify the date or time of the failure and do not state a cause (e.g., peak flow or high tide).

PLACEHOLDER Table D-1 History of Delta and Suisun Marsh Levee Failures and Flooding

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Sources of Water to the Delta

The Delta watershed covers 40 percent of the state (Figure D-2). Many of California's major rivers converge on the Delta as tributaries of the Sacramento, the state's largest river, or the San Joaquin River. Entering the Delta separately are the Cosumnes, Mokelumne, and Calaveras rivers, the Yolo Bypass, and numerous smaller creeks and sloughs. The Sacramento River is the single outlet to Suisun Bay. For more

on these rivers, see other Volume 2 reports for the Sacramento River and San Joaquin River hydrologic regions.

PLACEHOLDER Figure D-2 Sacramento-San Joaquin Delta Watershed

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Use of Water from the Delta

[This text still to be developed.]

Water Governance

The CALFED Bay-Delta Program was established to address the problems of water reliability, ecosystem restoration, levee integrity, and water quality in the Delta and its tributaries. It was a collaboration among 25 state and federal agencies that ultimately failed to reach agreement on the Delta's future. In 2006, Governor Schwarzenegger's Executive Order S-17-06 created the Delta Vision Task Force to create a vision to repair the ecological damage to the Delta. They declared that the Delta problems could not be solved in isolation – they were inextricably linked to statewide water supply, habitat, and flood management programs – and that stronger governance and accountability were a must. In response, the Delta Reform Act was crafted and passed by the Legislature.

Senate Bill X7 1 — Delta Reform Act

In 2009 the Legislature passed a series of water-related measures that included the Delta Reform Act. The Act established the coequal goals of a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem as overarching State policy and requires that the coequal goals be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. Furthermore, the Act notably required that Californians reduce their reliance on the Delta.

A new governance structure was created by the Delta Reform Act. It created the Delta Stewardship Council, the Sacramento-San Joaquin Delta Conservancy (Delta Conservancy), and reshaped the Delta Protection Commission. The Legislature intended these three agencies to fulfill different, yet interrelated and complementary, roles in the protection and enhancement of the Delta. Additionally, a new Delta Watermaster position was created at the State Water Resources Control Board.

Delta Stewardship Council

The Delta Stewardship Council is required to develop a comprehensive, legally enforceable direction for how the State manages important water and environmental resources in the Delta through the adoption of the Delta Plan. The Council is also to ensure implementation of the Delta Plan through coordination and oversight of State and local agencies proposing to fund, carry out, and approve Delta-related activities. The Delta Reform Act also established the Delta Science Program within the Council to ensure the appropriate use of science in Delta decision making.

Delta Conservancy

The Delta Conservancy was established to act as a primary state agency to implement ecosystem restoration in the Delta and support efforts that advance environmental protection and the economic well being of Delta residents. The Delta Conservancy is also directed to support efforts that protect, conserve, and restore the region's physical, agricultural, cultural, historical, and living resources.

Delta Protection Commission

The Delta Protection Commission is responsible for developing a long-term resource management plan for land uses within the primary zone of the Delta and is required by the Delta Reform Act to develop an economic sustainability plan for the Delta. Their goal is to ensure orderly, balanced conservation and development of Delta land resources and improved flood protection.

Delta Watermaster

The Delta Watermaster was created to oversee day-to-day administration of water rights, enforcement activities, and reports on water right activities regarding diversions in the Delta.

Agencies with Responsibilities in the Delta

More than 200 public agencies—federal, State, regional, and local—dot the Delta and Suisun Marsh waterways and claim partial responsibility for governance, planning, facilities, or resource protections that utilize and safeguard the ecosystem. These diverse public agencies, and the legal requirements that guide them, form a complicated patchwork of governance with a complex history and an uncertain future. Table D-2 is a partial listing of the more than 200 local, State, and federal agencies that have some jurisdiction and authority in governing water in and through the Delta.

PLACEHOLDER Table D-2 Agencies with Responsibilities in the Delta

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Flood Management Governance and Laws

California's water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary responsibility might be assigned to a specific local entity, aggregate responsibilities for flood management are spread among more than 200 agencies in the Sacramento-San Joaquin Delta Area with many different governance structures a list of these agencies can be found in California's Flood Future Report on page ___ Table ___. These governmental entities are collectively responsible for operating and maintaining water management facilities, as well as maintaining and upgrading levees that protect lands and assets in the Delta area. Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, a memorandum of understanding with other agencies, or facility ownership.

Senate Bill (SB) 5 (2008), Flood Management, requires the DWR and the CVFPB to prepare and adopt a Central Valley Flood Protection Plan (CVFPP) by 2012. The CVFPP was adopted in June 2012. The bill requires cities and counties in the Sacramento-San Joaquin Valley to amend general plans, within 24 months of June 2012, to contain feasible implementation measures designed to carry out the goals, policies, and objectives to reduce the risk of flood damage, based on data and analysis contained in the

CVFPP. Each county shall develop flood emergency plans in collaboration with cities within its jurisdiction. Within 36 months of June 2012, cities and counties of the Sacramento-San Joaquin Valley are required to amend zoning ordinances to be consistent with the amended general plans. By 2015, these cities or counties will be prohibited from entering into a development agreement, approving any permit, entitlement, or subdivision map unless an urban level of flood protection is provided in urban and urbanizing areas or until the FEMA standard of flood protection is provided in non-urbanized areas. The urban level of flood protection is defined as protection against flooding that has a 1-in-200 chance of occurring in any given year.

A number of laws regarding flood risk and land use planning were enacted in 2007. These laws establish a comprehensive approach to improving flood management by addressing system deficiencies, improving flood risk information, and encouraging links between land use planning and flood management. Many of the requirements set down by these laws are only applicable within the Central Valley. A of the legislation is provided below and a summary of each is available in the California's Flood Future Report on page ___.

- Senate Bill (SB) 5 (2008) Flood Management Assembly Bill (AB) 156 (2007) Flood AB 70 (2007) Flood Liability.
- AB 162 (2007) General Plans The Sacramento-San Joaquin Delta Reform Act of 2009:

Water Code sections 85020(g), 85225, and 85305-85309 have special significance to flood management activities in the Delta and are summarized in California's Flood Future Report pages ___ to ____.

A number of proposed regulatory policies in the draft Delta Plan would, if adopted, require covered actions to file for consistency with the Delta Plan policies, prioritize State investments in Delta levees and risk reduction, require flood protection for residential development in rural areas, protect floodways and floodplains, as well as expand floodplains and riparian habitats in levee projects. The Delta Plan and proposed regulatory policies are scheduled to be finalized and adopted by the end of 2012.

Unique Characteristics

The Delta is a unique place distinguished by its geography, Legacy Communities, a rural and agricultural setting, vibrant natural resources, and a mix of economic activities. The Legislature has found that the Delta's uniqueness is particularly characterized by its hundreds of miles of meandering waterways and the many islands adjacent to them, and has described the Delta's highly productive agriculture, recreational assets, fisheries, and wildlife as invaluable resources (Water Code section 12981 (b)). The Delta Plan (DSC 2012) recognizes the following values that make the Delta a distinctive and special place:

- The Delta's geography of low-lying islands and tracts shaped by sloughs, shipping channels, and rivers; tidal influences; levees, and other water controls is unique among California landscapes.
- The Delta retains a rural heritage, characterized by farms and small towns linked by navigable waterways and winding country roads.
- The Delta's agricultural economy is vital to the region and to the state.
- The Delta is a region where maritime ports, commercial agriculture, and expanding cities coexist with a unique native ecosystem that is home to many species of wildlife and fish.
- The Delta is a place of ethnic tradition, Legacy Communities, and family farms.

- The Delta provides opportunities for recreation and tourism because of its unique geography, mix of opportunities, and rich natural resources.

Ecosystem

The Delta is a floodplain estuary that connects river to ocean and land to water. Floodplain estuaries are among the most productive ecosystems on the planet. The high productivity associated with floodplain estuaries is driven by the intimate relationship between land and water. However, compared to other estuaries, the Delta has very low levels of pelagic primary productivity in both the Suisun Marsh and the Delta.

Historically, the Delta consisted of hundreds of miles of tidally influenced sloughs and channels and hundreds of thousands of acres of marsh and overflow land. At one time, the Delta supported hundreds of species, including the grizzly bear, tule elk, and gray wolf. As land reclamation took place and levees were built, the ecosystem changed. More than 90 percent of the marshland was converted to farms (and more recently, urban uses). The grizzly bear and gray wolf no longer reside in the Delta, but a population of tule elk has been established in the Suisun Marsh. The numbers of birds using the Delta have declined as well due to land reclamation, although changes in cropping patterns have allowed populations of some species to increase.

The Suisun Marsh is the largest contiguous brackish water marsh remaining on the west coast of North America and is a critical part of the Bay-Delta estuary ecosystem. The Marsh encompasses more than 10% of California's remaining natural wetlands and serves as the resting and feeding ground for thousands of birds migrating on the Pacific Flyway and resident waterfowl. The marsh also serves as a critical link for anadromous fish and is thought to be an important nursery for fish.

Land Use

The Delta is not a region unto itself. As noted previously, the Delta is made up of six counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo. The Delta area, which includes the legal Delta and the Suisun Marsh, totals approximately 1,315 square miles or about 840,000 acres. Figure D-3 shows the county boundaries and the general land use in the Delta and Suisun Marsh.

PLACEHOLDER Figure D-3 County Boundaries and General Land Use

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Before 1850, the Delta was essentially a broad expanse of water-based habitat and natural channels. The Delta was a water highway between San Francisco and Sacramento and the Gold Country. The fastest and most direct means of travel between Sacramento and San Francisco was by ferryboat. Large-scale reclamation of the Delta for agriculture began in 1868, and by 1900, most of the lands with mineral-organic soils, around the Delta's exterior, were reclaimed. The final period of Delta reclamation occurred between 1900 and 1920 on lands in the Delta's interior. The result of these reclamation efforts is largely what is seen as the Delta today—approximately 700 miles of meandering waterways and 1,100 miles of levees protecting more than 538,000 acres of farmland, homes, and other structures.

Today, the Delta is dominated by highly productive agricultural land. The main crops grown in the Delta are corn, alfalfa, pasture, tomatoes and grapes. Historically, asparagus, corn, pasture, alfalfa, and sugar beets were the dominant crops. In addition to changes in crops, the amount of urban and native lands has increased in the Delta, but agricultural lands have decreased.

Small communities and historic legacy towns within the Delta's Primary Zone serve as social and service centers for surrounding farms. These communities include Clarksburg, Courtland, Hood, Locke, Ryde, and Walnut Grove. A small portion of Rio Vista lies within the Primary Zone. Some communities within or just outside the Secondary Zone are the incorporated city of Isleton and portions of Stockton, Pittsburg, Antioch, Oakley, Sacramento, and West Sacramento.

The Delta was given a legal boundary (Section 12220 of the Water Code) in 1959 with the passage of the Delta Protection Act (see Figure D-1). Anticipating the potential effects of urban development on the Delta, the original Act was refined in 1992 to provide Primary and Secondary Zones within the previously defined legal Delta and the development of a Resource Management Plan for land uses within the Primary Zone. The Primary Zone (about two-thirds of Delta area) was intended to remain relatively free from urban and suburban encroachment to protect agriculture, wildlife habitat, and recreation uses. Urban development in the Secondary Zone (the remaining one-third) was intended to include an appropriate buffer zone to prevent impacts on the lands in the Primary Zone.

Senate Bill X7-1 directs the Delta Protection Commission to prepare and submit to the Legislature recommendations regarding the potential expansion of or change to the Primary Zone of the Delta. The Primary Zone Study was completed in 2010, but the DPC has not submitted any recommendations for changes to the Primary and/or Secondary Zones to the legislature.

The Delta Protection Commission updated the 1995 Resource Management Plan in 2010. Several policies and recommendations in the Land Use and Resource Management Plan for the Primary Zone of the Delta are applicable to the Water Plan. These include:

- Water Policy 1. "State, federal and local agencies shall be strongly encouraged to preserve and protect the water quality of the Delta both for in-stream purposes and for human use and consumption."
- Water Policy 2. "Ensure that Delta water rights and water contracts are respected and protected, including area of origin water rights and riparian water rights."

There has been significant population growth within the Legal Delta since 1990, almost entirely attributable to the expanding urban areas contained within the Secondary Zone. Specifically, the Secondary Zone contains an estimated 560,000 residents according to the 2010 Decennial Census, up from about 360,000 in 1990, a 56 percent increase (the state as a whole increased by 25 percent during this period). In contrast, the Census reports roughly 12,000 residents living in the Primary Zone in 2010, about the same number as 20 years ago. Currently, the population within the Primary Delta represents about 2 percent of the Legal Delta's total and this proportion appears to be shrinking (DPC 2012).

The Primary Zone encompasses about 67 percent of the Legal Delta's total land area. It is a highly rural and sparsely populated area surrounded by relatively fast-growing urban areas in or adjacent to the Secondary Zone. A variety of inter-related factors are preventing growth in the Secondary Zone from spreading to the Primary Zone, most notably regulatory prohibitions, lack of public infrastructure, and

economic feasibility. The relatively fast growth in the Secondary Zone is largely attributable to its role in accommodating spill-over growth from large, land-constrained urban centers in the San Francisco, Sacramento, and Stockton metropolitan areas.

The Delta's economy, like its population, is primarily urban and service oriented. However, the Delta Reform Act of 2009 and the Delta Protection Act of 1992 are primarily concerned with the natural resources of the Delta and the economic activity sustained by those resources such as agriculture and outdoor recreation. In addition, the resources of the Delta support significant water, energy, and transportation infrastructure that serve the Delta, regional and state economies, and an important commercial and recreational salmon fishery throughout the state.

The Stockton and Sacramento Deep Water Ship Channels were constructed in 1933 and 1963, respectively. Recent volume was 0.7 and 2.9 million metric tons in Sacramento and Stockton, respectively. The Port of Sacramento has seen an average decline in tonnage since 1994. This is related to reductions in agricultural and forestry shipments, which were the mainstay of operations at the port. Cargo levels through the Port of Stockton have continued to grow, and in 2005 Stockton became the fourth busiest port in California, after Los Angeles, Long Beach, and Oakland. Both ports are currently investigating the use of barges to move goods between California's coastal ports and the Central Valley.

Agriculture

Agriculture is among the qualities that define the Delta as a place. Creating farmland was the purpose for the Delta's initial reclamation, and for the maintenance of its levees and water controls. Agriculture benefits from the Delta's productive soils, special climate, and abundant water. Close to 80 percent of all farmland in the Delta is classified as Prime Farmland, the California Farmland Mapping and Monitoring Program's highest designated tier (DPC, 2012). Because of the fertile peat soils and the moderating marine influence, Delta agriculture's per-acre yields are almost 50 percent higher than the state's average (Trott 2007).

The main crops grown in the Delta are corn, alfalfa, tomatoes, wheat and wine grapes. In 2009 the total value of Delta crops was approximately $702 million. When related value-added manufacturing such as wineries, canneries, and dairy products are included, the statewide impact of Delta agriculture is 25,125 jobs, $2.135 billion in value added, and $5.372 billion in economic output (DPC, 2012).

In addition to the economic value of agricultural lands, some lands provide rich seasonal wildlife habitat. Thousands of acres of agricultural lands are flooded after harvest and provide feeding and resting areas for resident and migratory birds and other wildlife. This practice of seasonal flooding helps maximize the wildlife values of agricultural areas and lessen opportunities for agricultural pests.

While agriculture is the primary land use in the Delta, the total area of agricultural lands in the combined Delta and Suisun Marsh area has declined from about 549,420 acres in 1984 to 460,450 acres in 2008 (DSC 2012). The continued viability of agriculture in the Delta will require the protection of sufficient farmland and fresh water to support commercially viable operations and provide ways for agriculture to coexist with habitat restoration.

Recreation

Recreation is an integral part of the Delta, complementing its multiple resources and contributing to the economic vitality and livability of the region. Residents of nearby areas visit virtually every day, generating a total of roughly 12 million visitor days of use annually and a direct economic impact of more than a quarter of a billion dollars in spending (DPC 2012). The region's mix of land and water offers diverse recreation experiences and facilities, including fishing, boating, bird watching, other nature activities, hunting, enjoying restaurants, campgrounds, picnic areas, and historic towns and buildings.

The California Department of Parks and Recreation prepared a Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh in May 2011, which recommends enhancing California State Parks and other State agencies' properties and programs to create a network of recreation areas in the Delta, and encourages improvement of public access along the shorelines of growing Delta communities. It recommends that recreation improvements be provided in new water management and habitat restoration projects where consistent with the projects' purpose. Future prospects for Delta recreation and tourism will be strongly influenced by decisions about the Delta ecosystem, water quality, levee improvements, and governance, including land use and environmental standards. The Bay Delta Conservation Plan, Delta water quality plans, levee investments, and other decisions yet to be made can all significantly affect recreation and tourism.

PLACEHOLDER Photo D-1 Recreating in the Delta

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Legacy Communities

The Delta Reform Act of 2009 (SB X7 1) identifies the Delta's Legacy Communities as Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove. Each community has its own character. Bethel Island is a recreation destination. Clarksburg and Courtland are centers for wine and pear production. Freeport and Hood were transportation centers, with river landings and rail spurs to move goods. Locke and Walnut Grove had large Asian populations who worked at packing sheds and surrounding local farms. Ryde is known for its landmark hotel, and Isleton is known for festivals and visitor-serving businesses. Rio Vista is the largest community, and Knightsen is a small community known for several nearby horse ranches. All the Legacy Communities except Isleton and Bethel Island are in the Delta's Primary Zone.

Subsidence

The reclamation of Delta islands and their cultivation for agriculture initiated a process of land subsidence, mostly due to oxidation of peat soils, but also from wind erosion. Drainage and cultivation dried the saturated peat, reducing its volume by approximately 50 percent. Early cultivation practices also included burning, which further reduced the volume of the soil and altered its structure. Over time, long-term oxidation reduced about 2.6 to 3.3 billion cubic yards of these peaty soils to small particles and gases. As a result, most of the central Delta today is below sea level, with some islands commonly 12 to 15 feet below sea level (see Figure D-4). Although subsidence has slowed in some areas, other regions of the Delta continue to lose soil to oxidation and wind erosion at a rate of 5 to 15 tons/acre/year. It is projected that some areas of the Delta could subside an additional 2 to 4 feet by 2050 (Deverel and Leighton 2010).

PLACEHOLDER Figure D-4 Land Subsidence in the Delta

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Suisun Marsh

Historically, the Suisun Marsh consisted of 68,000 acres of tidally inundated islands separated by sloughs. Diking of Suisun Bay, primarily for livestock grazing, began around the mid-1860s. Shortly thereafter the first duck clubs were established around the marsh ponds. By the early 1900s, livestock grazing was giving way to other agricultural activities. Eventually, increasing salinity and land subsidence caused agricultural activities to fail and be replaced by duck clubs. Levees originally constructed for farming are now an integral part of the infrastructure of the duck clubs (URS 2007).

The Suisun Soil Conservation District was formed in 1963 (later named the Suisun Resource Conservation District). The SRCD is a special district of the State of California that represents private landowners in the Suisun Marsh on a variety of issues at federal, State, and local levels. The goals of SRCD are to achieve water supply of adequate quality to promote preferred waterfowl habitat and retain wetland resource values through appropriate management practices.

In 1974, the California Legislature passed the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act. The Act directed the San Francisco Bay Conservation and Development Commission (BCDC) and the California Department of Fish and Game (DFG) to prepare the Suisun Marsh Protection Plan. The Suisun Marsh Protection Plan includes a Primary Management Area (see Figure D-1) encompassing 89,000 acres and a Secondary Management Area that includes approximately 22,500 acres of significant buffer lands. The BCDC has land use and development permitting authority in the Primary Management Area.

Currently, 90 percent of the wetlands in the Suisun Marsh are diked and managed as food, cover, and nesting habitat for wildlife. The balance of the Suisun Marsh is privately owned, with 150 individual waterfowl hunting clubs and numerous upland parcels for cattle grazing. DFG owns nearly 15,300 acres of managed and tidal wetlands. Urban encroachment has not occurred within the marsh, but conflicts and pressures are occurring with the increasing urbanization and industrialization up to the edges of the Suisun Marsh Secondary Management Area.

PLACEHOLDER Photo D-2 Suisun Marsh

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Tribal

Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate Tribes and representatives within a region is maintained by the Native American Heritage Commission. The following is a list of the Tribes with historical or cultural ties to the Delta region, according to the commission.

- California Valley Miwok Tribe
- Cortina Band of Indians

- Ione Band of Miwok Indians
- North Valley Yokuts Tribe
- Rumsey Indian Rancheria of Wintun
- Shingle Springs Band of Miwok Indians
- The Ohlone Indian Tribe
- United Auburn Indian Community of the Auburn Rancheria
- Wilton Rancheria

Flood Risk Management

Without the levees, Delta land could not be used as it is today for highly productive farming, homes, and conveyance of fresh water to support other areas of the state. People, property, agriculture, and infrastructure, including critical infrastructure (such as highways and railroads) depend upon levees to keep land areas that support these structures and functions from flooding. Virtually all assets and attributes of the Delta are dependent upon this levee system for protection from flooding. Levees protect land areas near and below sea level and provide for a network of channels that direct movement of water for flood control, irrigation, and municipal and industrial uses across and through the Delta.

The Sacramento-San Joaquin Delta and Suisun Marsh, at the confluence of the Sacramento and San Joaquin Rivers, provide drainage for about 42,500 square miles of land and 40 percent of California's total runoff. Before the Delta was modified by levees and other structures, overflow of the rivers from winter storms and snowmelt would flood the Delta's low-lying islands and floodplains for long periods each spring. The risk of flooding was exacerbated by heavy sediment deposits in Central Valley Rivers, discharged during the Gold Rush, resulting in reduced channel capacities.

A substantial portion of the Sacramento-San Joaquin Delta Area is within the implementation area of the 2012 Central Valley Flood Protection Plan (CVFPP). The CVFPP proposes a system wide investment approach for sustainable, integrated water management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). There are about 385 miles of project levees and 732 miles of nonproject levees in the Delta [a figure showing the levees may be available as an online feature with all maps for this regional report]. (Project levees are those levees that are part of the Federal-State flood protection system in the Sacramento-San Joaquin Valley of California. These are levees of federally authorized projects for which the State has provided assurances of cooperation to the Federal government and are considered part of the State Plan of Flood Control.)

The SPFC represents a portion of the Central Valley flood management system for which the State has special responsibilities, as defined in the California Water Code Section 9110 (f). The SPFC Descriptive Document (DWR, 2010) provides a detailed inventory and description of the levees, weirs, bypass channels, pumps, dams, and other structures included in the SPFC.

Much of the Central Valley levee system, including those in the Delta, was built over many years using the sands, silts, clays, and soils, including organic soils that were conveniently available, often poorly compacted over permeable foundations. The system was designed to contain the record floods of the early twentieth century with the goal of fostering development of an agriculturally oriented economy and promoting public safety. The subsequent construction of a series of multi-purpose reservoirs with substantial flood control capability significantly augmented the capacity of the flood management system and contributed greatly to the State's economic development and public safety objectives. These

reservoirs constituted the principal response to the mid-century recognition that extreme floods that were much larger than those that guided design of the levee system were reasonably foreseeable.

Although the SPFC has prevented billions of dollars in flood damages since its construction, a better understanding of the risk assessment and engineering standards has made it clear that some SFPC facilities face an unacceptably high chance of failure. This, combined with continued urbanization in the floodplains, has increased the estimated level of flood risk. While the chance and frequency of flooding have decreased since construction of the SPFC and multi-purpose reservoirs, the damages that would occur if a levee were to fail in one of the urban areas are much greater, resulting in a net long-term increase in cumulative damages if no action is taken to improve the flood management system and limit further development in these areas.

Constructed facilities in the Sacramento-San Joaquin Delta Area include the extensive system of levees that provides flood protection to the 70 major islands and tracts, as well as improved channels, gates, and control structures that serve multiple purposes, including water supply conveyance, salinity control, and fisheries protection. An island-by-island list of project and nonproject levees, as well as some of the major water facilities is available in the California's Flood Future Report on page ___ Table ___.

Unique Challenges/Drivers of Change

The Delta and Suisun Marsh ecosystem, as a large component of the San Francisco Estuary, was once one of the most biologically productive and diverse ecosystems on the west coast, supporting a wide array of native plant and wildlife species and providing important habitat for many migratory species. The Delta ecosystem is now in peril. As a result of human activity to reclaim farmland, protect areas from flood, and provide water for agriculture and communities; discharge of wastes from agriculture, industry, and urban areas; and the introduction of harmful invasive species, the Delta has been modified in ways that adversely influence ecosystem function and compromise its ability to support a healthy ecosystem. These changes not only affect the species that live there, but also the ecosystem services that benefit humans, such as improved water quality, agricultural productivity, healthy commercial and sport fisheries, flood protection, and recreation.

One example of the decline of the Delta Ecosystem is the pelagic organism decline (POD). Abundance indices calculated by the Interagency Ecological Program (IEP) through 2007 suggest marked declines in four pelagic fishes in the upper San Francisco Estuary (the Delta and Suisun Bay). These fishes include delta smelt, which is listed under State and federal Endangered Species acts as endangered and threatened, respectively and the longfin smelt protected under California's Endangered Species law as a threatened species. Although the numbers had historically fluctuated, this steep and lasting dropoff signaled an ecological crisis.

There are many factors and actions that have stressed the Delta ecosystem and collectively are termed "stressors." The Delta Independent Science Board categorized these stressors into broad groups to assist in evaluating management options. These categories include current stressors, legacy stressors, globally determined stressors, and anticipated stressors. Below is a discussion of the current stressors in the Delta as identified in the Delta Plan (DSC, 2012).

Altered Delta Flows

Native species are adapted to the seasonal, interannual, and spatial variability of the historical flow pattern and the functions that come with it. Flow interacts with land to create physical habitats and connections where species find food, refuge, and reproduction space. Through a variety of mechanisms, native species can survive, grow, and reproduce better when flows occur in more natural historical patterns.

Present-day Delta flows are very different from historical, natural flows. Water flows have been altered by water supply and flood control structures and draining of floodplains, wetlands, and groundwater basins. Current flow management regulations provide some protection for ecological functions and native species, but the current Delta flow regime is generally harmful to many native aquatic species while encouraging nonnative aquatic species (SWRCB 2010).

Habitat Degradation and Loss

Much of the original habitat for the Delta's native fish, wildlife, and plants has been urbanized or converted to agriculture over the last 160 years (Healey et al. 2008, Moyle et al. 2010, Baxter et al. 2010). The current Delta ecosystem continues to be productive, but its habitat types and conditions support a much different mix of species that the historical Delta, and many of the currently thriving species are nonnative. Inadequate habitat for native species that reside in and migrate through the Delta is an important current ecosystem stressor that is affected by and interacts with many other stressors.

Impaired Water Quality

The location, extent, and dynamics of the freshwater-saltwater interface in the Bay-Delta is an important factor in the distribution and abundance of many fish, invertebrate, and plant species, and is largely determined by the amount of fresh water flowing from the Delta west into Suisun Bay. The Delta ecosystem is also affected by a variety of pollutants discharged into Delta and tributary waters. Pollutants of concern affecting Delta biological species and ecosystem processes include nutrients, pesticides, mercury, selenium, and other persistent bioaccumulative toxic substances. More detail on how these constituents affect the Delta can be found under the Water Quality section.

Nonnative Species

Nonnative species in the Delta create a wide range of stresses on native species. They have altered food webs and habitats, they compete with native species for resources, and they directly prey upon native species. Nonnative species have been introduced into the Delta over time via watercraft, fishing gear, live bait, intentionally (either legally or illegally) introduced for recreational or other purposes, or released from aquariums into the environment (DFG 2011).

Introduced species now dominate all habitats in the Delta. Among the introduced species of the Delta, the most visible is the aquatic weed *Egeria densa*, which often fills low-velocity channels in the central and southern Delta and reduces water turbidity. Two clams from Asia dominate the benthos of the Delta: the Asian clam, *Corbicula fluminea*, is most abundant in fresh water, and the overbite clam, *Corbula amurensis*, is abundant in brackish to saline water. Striped bass and largemouth bass, both deliberate introductions, are not only among the most abundant fish of pelagic and nearshore habitats, they are also predatory and probably have a negative effect on natives.

Another invasive species water hyacinth, *Eichhornia crassipes*, showed up in California more than 100 years ago. Water hyacinth was first reported in California in 1904 in a Yolo County slough. There were increased reports of water hyacinth in the Delta region during the 1970s; and by 1981, water hyacinth covered 1,000 acres of the Delta and 150 of the 700 miles of waterways.

Impacts of Hatcheries and Harvest Management

Hatcheries can introduce diseases to wild fish populations and alter their genetic makeup, thus, affecting their ability to perform in the wild. Inappropriate or insufficient fishing regulations and practices also can have wide-ranging effects, from overfishing that reduces genetic diversity to food web and ecological changes.

Need for Water Supply Reliability

Over the past several decades, increasing demand for the Delta's resources have increased the conflict between the needs of water users and efforts to sustain the estuary's aquatic ecosystem and support recovery of State and federally listed fish. These conflicts have led to a crisis regarding the ability to protect Delta fisheries, maintain water quality, and meet the needs of both in-Delta and export area agricultural and municipal water users. This situation has resulted in the need to address these competing beneficial uses and sustainability concerns.

Delta export reliability hinges on first satisfying water quality requirements for native Delta fish and the criteria for in-Delta flow and water quality standards. The in-Delta water quality conditions will fluctuate with seawater intrusion, the quality and quantity of river and small stream inflows, in-Delta water management operations, and export pumping operations. Required inflows to the in-Delta ecosystem will also depend on the health of indigenous species and invasive species management actions.

Existing Delta conveyance does not provide long-term reliability to meet current and projected needs. Conveyance through the Delta in times of drought is especially challenging considering the various demands from agriculture, municipalities, and environmental needs. To improve through-Delta conveyance water supply reliability and provide greater operational flexibility, improvements to existing facilities in the form of updating aging infrastructure, upgrading existing capacities, adding redundancy to the system and constructing additional facilities may be needed.

The major issues pertaining to reliability of water supply transferred through the Delta include the following items.

- The health of the Delta ecosystem is paramount in consideration of water-related activities within the Delta. Continuing declines in some native species populations migrating through or living in the Delta, such as salmon and delta smelt, highlight the increasing influence of the Delta ecosystem on water supply reliability. Any activity proposed for Delta conveyance will need to consider the restoration and preservation of native habitat to benefit pelagic organisms and other native species.
- The integrity of more than 385 miles of Project levees and over 730 miles of non-Project levees throughout the Delta is continually undermined by such elements as storm events creating floods and seawater surges, island subsidence, natural levee erosion, poor quality peat soils used to build the original levees, seismic activity, burrowing animals, and sea level rise. These vulnerabilities call into question the long-term sustainability of using the Delta as a conveyance

corridor. DWR's forthcoming Delta Risk Management Strategy Phase II report will recommend levee standards for the Delta to increase through-Delta water supply reliability and reduce risks to water conveyance and other values in the Delta overall. In addition, DWR has developed an emergency response plan that has put in place tools to protect the Delta.

- Maintaining optimal water quality within the Delta for both drinking water and for native species habitat will be a challenge. Constituents of concern include, but are not limited to, salinity, bromide, chloride, organic carbon, nutrients, pathogens, dissolved oxygen, temperature, and turbidity. Control of water quality in a tidal estuary with seasonal and yearly fluctuating hydrology will require well understood and fully inclusive strategies. As water quality requirements can vary and at times conflict among users, the challenge will be to agree upon the implementation strategy.
- Maintenance of in-Delta projects for beneficial uses such as recreational boating and swimming; sport fishing; shipping; and agriculture, industrial, and drinking water supply will be an ongoing management challenge as political and fiscal climates evolve and resources for competing priorities become scarcer.

Flood Risk

Flood management in the Sacramento-San Joaquin Delta Area of California has a unique set of challenges, due to the unique nature of the levee system that protects the lands and assets, as well as the multiple uses of the system of waterways for water supply, habitat, and recreational purposes. Typically, flood management agencies in large urban areas tend to be highly organized. Agencies in more rural counties or with low exposure to flooding are often handled by emergency responders or a single contact at the county. This can present a unique set of challenges when developing a project.

Many of these challenges were identified during meetings with local agencies in the Sacramento-San Joaquin Delta Area. These challenges include:

- Inadequate information on floods, including maps and data
- Inconsistent and unreliable funding
- Outdated, and ageing flood infrastructure
- Loss of accreditation of levees
- Economic impact of new 200-year urban level of flood protection standard

Climate Change

Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (CNRA, 2009). Model simulations using the Intergovernmental Panel on Climate Change's 21st century climate scenarios project increasing temperatures in California, with greater increases in the summer (Cayan, 2008). Changes in annual precipitation across California will result in changes to surface runoff timing, volume, and type. Due to the economic, geographical and biological diversity of the state, vulnerabilities and risks due to current and future anticipated changes are best assessed on a regional basis. While the State of California is taking aggressive action to mitigate climate change through greenhouse gas (GHG) reduction and other measures (CARB, 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (IPCC, 2007). Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Many resources are available to assist water managers and others in evaluating their region-specific

vulnerabilities and identifying appropriate adaptive actions (USEPA and DWR 2011; Cal-EMA and CNRA 2012).

Climate change impacts observed in California in the past 100 years include an increase in average temperatures of approximately one degree F, a decrease in the average early snowpack in the Sierra Nevada of about ten percent, and a rise in the mean sea level at Golden Gate Bridge in San Francisco Bay of seven inches (DWR 2008).

Future changes in annual precipitation across California, either in timing or total amount, will result from changes to type of precipitation (rain or snow) in a given area, and to surface runoff timing and volume. Climate model precipitation projections for the State are not all in agreement, but most anticipate drier conditions in the southern part of California, with heavier and warmer winter precipitation in the North (cite). Since there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Leung, Pacific Northwest National Laboratory, 2012). Temperature projections are in wide agreement on a warming trend statewide (cite). Future impacts may include as much as a 6-7 degree F increase in winter temperatures and 7-9 degree F increase in summer temperatures (Cal-EMA and CNRA 2012). In addition, mean sea levels are projected to rise 14 inches by 2050 and as much as 55 inches by 2100 (NRC 2012). Lying at the confluence of two major rivers, the Delta region is particularly vulnerable to the impacts of these changes.

The major rivers draining into the Delta region originate in the Cascade Range to the north and the Sierra Nevada range to the east and are fed primarily by snowmelt. Winter air temperatures in these mountain ranges are projected to increase by 4-8oF by 2100 (Cal-EMA and CNRA 2012). The Sierra Nevada snowpack is expected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. DWR projects that the Sierra Nevada will experience a 25-40 percent reduction of snowpack from its historic average by 2050 (DWR, 2008). The higher winter runoff may contribute to increased stress on Delta levees and shorten seasonal inundation of floodplains. Lower flows in the summer and fall could increase water temperatures, reduce water quality, and result in greater salinity intrusion. These changes could contribute to biodiversity shifts, loss of agricultural productivity, and additional pumping restrictions.

Precipitation is also expected to become more variable, with more extreme wet and dry conditions. Larger storm events in the Delta will put additional stress on the levees and contribute to more frequent levee failures. Levee failures can result in the direct loss of life and property and also to disruption in important services or transportation corridors. It can also result in salinity intrusion, reducing agricultural productivity in the region and disruptions to SWP and CVP operations. Longer periods of drought could impact the region as well. Lower flows into the Delta will contribute to increased water temperatures, greater salinity intrusion, and reduced water quality putting greater stress on the ecosystem, reducing agricultural productivity, and impacting SWP and CVP operations.

In addition to these changes, land surfaces in the Delta are subsiding increasing the region’s vulnerability to sea level rise. A 55 inch rise in mean sea level would increase the amount of land vulnerable to a 100-year flood event, though the amount varies throughout the region. Models project that 14% of the acreage in Solano County would be more vulnerable to a 100-year flood event; however that number increased to 40% in Contra Costa County and up to 59% in Sacramento County (CalEma and CNRA 2012). In addition to higher flood risk due to storm events, rising sea levels will inundate low lying areas and

increase salinity intrusion into the Delta. The potential impacts to the region include an increase in the risk of levee failure, loss of agricultural land and productivity, loss of wetlands, reduced water quality, contamination of groundwater supplies, more water dedicated to meeting water quality standards, biodiversity shifts, increased vulnerability to invasive species, and changes to SWP and CVP operations.

The Delta region is economically dependent on the thriving agricultural industry, which will be affected by a more variable hydrologic regime, salinity intrusion, increased levels of pests and disease, increased evapotranspiration, and other indirect effects of rising temperatures. In some instances a longer growing season will be beneficial, but productivity of some crops may decline.

Regional Resource Management Conditions

Environmental Water

A diverse set of conditions in the Delta helped shape a unique ecosystem from which hundreds of aquatic species, many endemic to the system, evolved. Reclaiming and maintaining the Delta for agriculture, urban areas, transportation corridors and utilities and managing the Delta as a water conveyance and supply system altered many of these conditions in ways that continue to challenge management of the system.

Since development within the Delta began, operation and management of the water conveyance and supply system has continually evolved. History suggests that many of the management adjustments and changes that have been made over the years within the Delta have fallen short in addressing the environmental or water quality concerns these actions were designed to resolve.

Requirements of the State Water Resource Control Board (State Water Board) and the biological opinions for endangered species largely determine requirements for water quality, flow, and CVP/SWP project operations in the Delta and Suisun Marsh. On occasion, the State Water Board requirements are preceded by requirements set by other agencies such as the US Fish and Wildlife Service (USFWS). For example, in their middle 1990s Delta Smelt/Sacramento Splittail Biological Opinions, the USFWS set CVP/SWP operational criteria which were ultimately folded into the State Water Board's D-1641. Further, requirements outlined in contractual agreements such as those between DWR and the North Delta Water Agency play a role in Delta water quality, flow, and CVP/SWP project operations.

The SWP and the CVP coordinate project operations to maintain the standards established by D-1641 and the biological opinions, by releasing water from upstream reservoirs for in-Delta as well as Delta outflow requirements, by curtailing export pumping at the SWP Banks and CVP Tracy Pumping Plants during specified time periods and meeting salinity standards in the Suisun Marsh. A sampling of requirements imposed on project operations are further described in a subsequent Project Operations section.

Ecosystem Restoration

Ecosystem Restoration Program Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions

The DFG Conservation Strategy describes future restoration priorities and actions of the Sacramento-San Joaquin Delta, the Sacramento Valley and the San Joaquin Valley Regions. It further provides the conceptual framework and process that will guide the refinement, evaluation, prioritization, implementation, monitoring, and review of ERP actions. The Conservation Strategy can be found online at: http://www.dfg.ca.gov/erp/reports_docs.asp

Suisun Marsh Habitat Management, Preservation, and Restoration Plan

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan is a comprehensive plan designed to address the various conflicts regarding use of marsh resources, with the focus on achieving an acceptable multi-stakeholder approach to restoring 5,000 to 7,000 acres of tidal wetlands and the management of managed wetlands and their functions consistent with the CALFED program, the Suisun Marsh Preservation Agreement, applicable species recovery plans, and other interagency goals.

Fish Restoration Program Agreement

The Fish Restoration Program Agreement (FRPA), between the Department of Fish and Game and DWR, was signed on October 18, 2010. FRPA addresses specific habitat restoration requirements of the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) biological opinions (Biological Opinions) for State Water Project and Central Valley Project operations. FRPA is also intended to address the habitat requirements of the DFG Longfin Smelt Incidental Take Permit (ITP) for SWP Delta operations. The primary objective of the FRPA program is to implement the fish habitat restoration requirements and related actions of the Biological Opinions and the ITP in the Delta, Suisun Marsh, and Yolo Bypass and is focused on 8,000 acres of intertidal and associated subtidal habitat to benefit delta smelt, including 800 acres of mesohaline habitat to benefit longfin smelt, and a number of related actions for salmonids.

Bay Delta Conservation Plan

The Bay Delta Conservation Plan (BDCP) is a planning process intended to result in the issuance of permits from DFG under the Natural Community Conservation Planning Act and from the U.S. Fish and Wildlife Service and the National Marine Fisheries Service pursuant to Section 10 of the federal Endangered Species Act. The BDCP proposes to contribute to the restoration of the health of the Delta's ecological systems by contributing to a more natural flow pattern than existing conditions in the Delta and by implementing a comprehensive restoration program.

As currently proposed (BDCP 2012), the BDCP takes an approach to supporting landscape-level processes by creating a reserve system consisting of a mosaic of natural communities that would be adaptable to changing conditions (including sea-level rise) to sustain populations of covered species and maintain or increase native biodiversity. The proposal considers protection of at least 31,000 acres of existing natural communities and restoration or creation of at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. In addition, the BDCP is intended to improve the Delta ecosystem by taking actions such as:

- Protecting and improving habitat linkages to promote the movement of native species
- Accommodating future sea level rise by providing transitional areas that allow future upslope establishment of tidal wetlands
- Allowing natural flooding to promote the regeneration of vegetation and related ecosystem processes
- Connecting rivers and their floodplains to recharge groundwater, provide fish spawning and rearing habitat and increase food supply
- Managing the distribution and abundance of nonnative predators to reduce predation on native covered species

Example elements of the BDCP strategy to support natural communities include:

- Controlling invasive nonnative plant species
- Restoring or creating 5,000 acres of riparian forest
- Restoring corridors of riparian vegetation along 20 miles of channel margin
- Restoring 2,000 acres of grassland
- Protecting at least 20,000 acres of cultivated land to support suitable habitat for native species

Habitat Conservation Plans and Natural Community Conservation Plans

Several Habitat Conservation Plans (HCP) and Natural Community Conservation Plans (NCCP) are in place or under development in the Delta. These plans' propose to minimize and mitigate the impact of authorized incidental take of the endangered or rare species that the plans cover and to conserve these species and their habitats. Completed plans in the Delta include the San Joaquin HCP and East Contra Costa HCP/NCCP. The BDCP, Yolo County HCP/NCCP, South Sacramento HCP, and Solano Multispecies HCP are being developed.

Sacramento-San Joaquin Delta Conservancy

In 2009 the Legislature established the Delta Conservancy to act as a primary State agency to implement ecosystem restoration in the Delta and to support efforts that advance environmental protection and the economic well-being of Delta residents. The Delta Conservancy Strategic Plan was adopted in June 2012.

Delta Levees Special Flood Control Projects

DWR's Delta Levees Special Flood Control Projects program provides funding to local agencies in the Delta for habitat projects linked to flood management improvements. Similarly, the 2012 Central Valley Flood Protection Plan proposes new or enhanced flood bypasses, levee setbacks, and fish passage improvements that provide both flood risk reduction and habitat.

Water Supplies

In an average water year like 2000, the largest source of water was the Sacramento River, which transported a little more than 21 million acre-feet into the Delta. Additional flows from the San Joaquin River, and eastside tributaries such as the Mokelumne and Cosumnes rivers contributed just over 3.9 million acre-feet, with precipitation directly on the Delta adding about another 1 million acre-feet. Freshwater flows in the Delta are typically much less than those caused by tides. In addition to precipitation derived runoff, Pacific Ocean tides move into and out of the Delta, twice a day. Tidal rise and fall varies with location, from less than one foot in the eastern Delta to more than five feet in the western Delta.

A sizable amount of water from the Delta's watershed is diverted and used before it reaches the Delta as Figures D-5 and D-6 illustrate. Figure D-5 depicts historical diversions from the Delta; Figure D-6 shows historical diversions before the Delta, in-Delta uses, and exports and outflows to the ocean.

PLACEHOLDER Figure D-5 Historical Diversions from within the Delta

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

PLACEHOLDER Figure D-6 Historical Diversions before the Delta, In-Delta Uses and Exports from the Delta, Plus Outflows

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

The Suisun Marsh is a brackish marsh. Salinities vary seasonally with higher salinities in the summer and fall, and lower salinities in the winter and spring. There is always an east to west salinity gradient in the Suisun Marsh. During periods of local rainfall numerous creeks provide fresh water inflow to the northern areas of the marsh, seasonally decreasing the salinities of these regions. These creeks are Denverton, Union, Laural, Ledgewood, Suisun, Green Valley, Jameson Canyon and American Canyon.

Groundwater supplies in the Primary Zone of the Delta are continually recharged due to flows in Delta channels and the soft, deep soils of Delta islands. The water table is relatively shallow. A number of groundwater basins/subbasins touch on the Secondary Zone including Sacramento Valley/Solano Subbasin; San Joaquin Valley/Eastern San Joaquin and Tracy Subbasins; and the Suisun-Fairfield Valley Basin. Groundwater levels in most basins have declined as a result of agricultural and urban development. The Eastern San Joaquin Subbasin has been characterized as severely overdrafted with significant depressions east of Stockton and Lodi. Groundwater levels fluctuate with droughts, development, delivery of surface waters to the region, and periods of "wet" years.

Water Balance

A water balance is a good way to get an overview of the major flows into and out of the Delta. Three recent years 1998 (wet year), 2000 (average year), and 2001 (dry year) demonstrate typical fluctuations in Delta inflows/outflows (Figure D-7 shows Delta inflows/outflows for years 1998, 2000 and 2001). During these years, the water system was generally operated under the same rules as today. Some observations that can be made by looking at these three types of water years are:

- In-Delta consumptive use is similar most years
- Water export quantities show more variability but still are in a relatively narrow range
- The widest variability from year to year occurs in the outflow from the Delta. Net outflow to the bay/ocean in a wet year can be many times the outflow during a dry year.
- Water diversions and exports are a larger portion of the Delta inflow during a dry year.

PLACEHOLDER Figure D-7 Delta Inflows/Outflows for Years 1998, 2000, and 2001

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

The historical records show even larger flow ranges than represented in Figure D-7. For example, during water year 1983 (October 1982 through September 1983), more than 60 million acre-feet (maf) of water passed through the Delta to the San Francisco Bay. During water year 1977, only about 5 maf passed through the Delta to the bay.

Water Rights

Riparian water rights are entitlements to water that are held by owners of land bordering natural flows of water. A landowner has a right to divert a portion of the flow for reasonable and beneficial use on their land within the same watershed. Natural flows do not include return flows from use of groundwater, water stored and later released (e.g., by the State Water Project (SWP) or the Central Valley Project (CVP) for Delta export) or water diverted from another watershed.

Appropriative rights are held in the form of conditional permits or licenses from the State Water Resources Control Board (State Water Board). Appropriative rights can be applied to both riparian and non-riparian lands provided the riparian rights on a given stream are satisfied. Additionally, whether an appropriative right was initiated before or after 1914 affects the priority and legal history of the right and thus the regulation of the right.

A body of water rights law includes the area of origin, county of origin, watershed of origin, and Delta protection statutes. These laws were developed to retain the priority to subsequent appropriative uses within an area, county, or watershed, as against out-of-basin permitted appropriations. Specifically, they were enacted to protect local water users from appropriations by the CVP and SWP Project for use in areas outside the area of origin or the areas immediately adjacent to the areas of origin. Thus, area of origin statutes consist of a priority right to satisfy current uses, as well as a prospective priority right to satisfy future beneficial uses within a specifically identified geographic area.

The Delta Protection Act (1959) incorporates the area of origin protection to the Delta. Specifically, the Act declares as a policy of the state "that no person, corporation or public or private agency or the State or

the United States should divert water from the channels of the Sacramento-San Joaquin Delta to which the users within said Delta are entitled."

Contract Rights

The State Water Board authorizes and regulates diversion and export of water from the Delta by the SWP and CVP. The State Water Board first issued water rights permits to Reclamation for the operation of the CVP in 1958 (Water Rights Decision 893) and to DWR for operation of the SWP in 1967 (D-1275 and D-1291). Entitlements to surface water supplies can be obtained through contracting with the SWP and the CVP. The CVP and SWP contractors' have contractual rights as specified in the contracts. DWR has entered into contracts with water agencies in the Delta such as the North Delta Water Agency (NDWA). In the case of the NDWA, their contract provides assurances that users within the NDWA boundary have the right to divert water of a specific quantity for reasonable and beneficial uses for agricultural, municipal and industrial purposes.

Groundwater Rights

The following general overview of groundwater rights in California can be found on the State Water Board's Web site at http://www.waterboards.ca.gov/waterrights/board_info/water_rights_process.shtml. In most areas of California, overlying landowners may extract percolating groundwater and put it to beneficial use without approval from the State Water Board or a court. California does not have a permit process for regulation of groundwater use. In several basins, however, groundwater use is subject to regulation in accordance with court decrees adjudicating the groundwater rights within the basins.

The California Supreme Court decided in the 1903 case *Katz v. Walkinshaw* that the "reasonable use" provision that governs other types of water rights also applies to groundwater. Prior to this time, the English system of unregulated groundwater pumping had dominated, but it proved to be inappropriate to California's semiarid climate. The Supreme Court case established the concept of overlying rights, in which the rights of others with land overlying the aquifer must be taken into account. Later court decisions established that groundwater may be appropriated for use outside the basin, although appropriator's rights are subordinate to those with overlying rights.

Water Uses

Inside the Delta

Surface Water

Water use in the Delta region is mostly agricultural. Irrigation water is taken directly from the channels and sloughs through approximately 1,800 diversions, which together divert up to 5,000 cubic feet per second (cfs) during peak summer months. Though the primary water users in the Delta are individual farming operations, formal institutions have been established to manage Delta water. For instance, in November 1965, DWR and the US Bureau of Reclamation reached agreement with some Delta interests on the quality of agricultural water to be maintained by the SWP and the CVP at various locations in the Delta. There was, however, no legal entity to sign the related contracts. As a result, the California Legislature created the Delta Water Agency. This agency was replaced with three separate agencies in 1973 – the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. Contra Costa County Water District, East Contra Costa Irrigation District, Byron-Bethany

Irrigation District, the city of Antioch, and various industrial corporations are the remaining local water users within the Delta.

Most Delta farms use water under riparian and appropriative water rights, and drainage water from the islands is pumped back into the Delta waterways. In 2000, Delta agriculture used about 1.3 million acre-feet of water to irrigate about 476,000 acres of crops (Tully and Young 2007). In-Delta residential water is generally drawn through private wells or provided through community public water systems, such as the Contra Costa Water District. The remaining portion of water in the Delta is either used by the various forms of evapotranspiration or contributes to Delta outflow, through which it can provide wildlife habitat and salinity control benefits. Recreation water uses do not have a large effect on the Delta water balance, but are still important in the Delta, with an estimated 12 million "user days" recorded each year for recreation purposes.

Most Suisun Marsh managed wetlands begin flooding in the fall around October 1 in preparation for the fall migration of waterfowl. At the end of waterfowl season, water manipulation for habitat development may continue through July. Typically the water remaining in the wetlands is drained in June or July to allow vegetative growth and to perform routine maintenance activities during the summer work season.

Power generation plants at Antioch and Pittsburg are cooled with water diverted from the Delta. Combined, the two power plants' pumps can divert 3,240 cfs. The SWP's North Bay Aqueduct (NBA) and the CVP's Contra Costa Canal deliver water to Bay Area cities. In 2010, the SWP diverted about 43,000 acre-feet into the NBA and Contra Costa Water District withdrew about 94,000 acre-feet.

The federal C.W. "Bill" Jones Pumping Plant (formerly the Tracy Pumping Plant) can export about 4,600 cfs, primarily to CVP agricultural land south of the Delta. It also supplies some water to urban areas and to wildlife refuges. The SWP's Banks Pumping Plant has a physical export capacity of 10,500 cfs, but is currently permitted to generally divert only up to 6,680 cfs from the Delta into the pumping plant's Clifton Court Forebay. Diversions, first by the CVP in the 1950s and then the SWP starting in the 1960s have steadily increased over the years. The SWP provides water primarily to urban areas, but also supplies some water for agricultural uses. The SWP has contracts to deliver 4.2 million acre-feet annually. The CVP has contracts to deliver 3.1 million acre-feet annually from the Delta. The projects generally are not able to deliver their full contract amounts because the projects are also operated for Delta water quality requirements and fish protections. On average, the projects together have exported about 5 million acre-feet annually.

Groundwater

There is little known about groundwater use from the basins within the Delta's Secondary Zone with the exception of the East San Joaquin Subbasin. Various estimates place groundwater use in the East San Joaquin Subbasin at 730,000 to 800,000 acre-feet per year. The CALFED Programmatic EIS/EIR (2000) estimated that average annual groundwater withdrawals range from 100,000 to 150,000 acre-feet in upland areas of the Delta.

Recycled Water

According to the 2009 Municipal Wastewater Recycling Survey, compiled by the State Water Resources Control Board, 9115 acre feet per year are being recycled in the Delta. Most of the recycled water was used for agricultural irrigation or for wetlands and natural systems. (SWRCB. 2011a) State policy

(SWRCB. 2009) encourages increased use of recycled water but recognizes the potential of recycled water to contribute to exceeding or threatening to exceed water quality objectives due to salt and nutrients. Therefore, the policy requires stakeholders to work together to develop salt and nutrient management plans.

Outside the Delta

About half the state's runoff, which originates in the Sierra Nevada, flows through the Delta watershed. Many diversions in the Delta watershed occur in the upper watershed. On average, approximately 31 percent of the flow from the Delta watershed is diverted before it ever reaches the Delta (California Natural Resource Agency 2010). Some of the water diverted from the Delta tributaries is returned to the tributaries through wastewater effluent and agricultural return flows, albeit at a degraded quality.

Project Operations

The CVP Delta facilities include the Contra Costa Canal (CCC), the C.W. "Bill" Jones Pumping Plant, the Tracy Fish Collection Facility, the Delta Mendota Canal (DMC), and the Delta Cross Channel Canal (DCC). The CCC and DMC convey water from the Delta to Contra Costa County and the DMC and San Luis service areas. The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The C.W. "Bill" Jones Pumping Plant's diversion capacity is about 4,600 cfs.

The SWP facilities in the Delta include the North Bay Aqueduct (NBA), Clifton Court Forebay (CCF), John E Skinner Fish Facility, the Harvey O. Banks Pumping Plant, the Suisun Marsh Salinity Control Gates (SMSCG), several Suisun Marsh distribution systems (Roaring River and Morrow Island) and up to four temporary barriers in the south Delta. The NBA conveys water to Napa and Solano counties, and its maximum pumping capacity is 175 cfs. The CCF, Skinner Fish Facility, and Banks Pumping Plant, divert and convey water to SWP service areas south of the Delta including the South Bay. Daily diversions into the CCF are governed by an agreement with the US Army Corps of Engineers (USACE) (Public Notice 5820A). The current permitted average daily diversion at CCF is 6,680 cfs. The SMSCG are operated to meet marsh water quality standards. The Suisun Marsh water distribution systems are designed to provide lower salinity water to public and private managed wetlands and to discharge drainage water. Figure D-8 shows the locations of SWP and facilities.

PLACEHOLDER Figure D-8 Location of State Water Project and Central Valley Project facilities in the Delta-Suisun area

As noted in the Environmental Water section, the operations of the SWP/CVP are subject to many State and federal laws, agreements, biological opinions, contract requirements, flood operations, etc. that are designed to protect water quality, water supplies, wetlands, anadromous and native fisheries, migratory birds, threatened and endangered species, and to prevent flooding, etc. Table D-3 (laws, directives, and orders affecting CVP and SWP operations) lists several of these operational criteria and provides a summary description. An overview of several key actions is provided below:

- **Coordinated Operations Agreement.** The CVP and SWP release previously stored water into the Delta where they redivert the stored water and also divert natural flow to users mainly south and west of the Delta. The CVP and SWP use the Delta as a common conveyance facility. Reservoir releases and Delta exports must be coordinated to ensure that each project achieves its share of water supplies and bears it share of obligations to protect resources.

- **Suisun Marsh Preservation Agreement.** The State Water Board's D-1485 directed the CVP and SWP to develop a plan to protect Suisun Marsh resources. An agreement was signed in 1987 with the goal to mitigate the effects of the CVP and SWP operations and other upstream diversions on water quality in the marsh.
- **Endangered Fish Species Biological Opinions**. The general decline of several fish species, the Delta smelt and spring-run and winter-run salmon in particular, generated much concern resulting in a series of biological opinions from the NOAA Fisheries and US Fish and Wildlife Service (USFWS). These opinions ultimately established requirements to be met by the SWP and CVP to protect these species. These included requirements for Delta inflow and outflow, Delta Cross Channel gate closure, and reduced export pumping. Many of these fish protection requirements were incorporated into the 1995 water quality control plan (follows). New biological opinions issued in 2008 and 2009 modified some existing requirements such as additional Delta Cross Channel gate closures and slightly different Old & Middle River (OMR) flow targets, and added others, including a Fall X2 (habitat protection outflow) requirement in certain water year types.
- **1995 Water Quality Control Plan and Decision-1641.** The 1995 plan incorporated several changes recommended by the US Environmental Protection Agency (EPA), NOAA Fisheries, and USFWS to the objectives for salinity and endangered species protection. D-1641 implements the objectives in the 1995 Bay-Delta Plan, and it imposes flow and water quality objectives to assure protection of beneficial uses in the Delta. In essence, the requirements in D-1641 address standards for fish and wildlife protection, municipal and industrial water quality, agricultural water quality, and Suisun Marsh salinity. The decision added new provisions for X2, export/info ratio, and the Vernalis Adaptive Management Program (VAMP). Meeting the standards was accomplished through changes in the water rights of the CVP, SWP, and others. The State Water Board also granted conditional changes to the point of diversion for the CVP and SWP, in the southern Delta, with D-1641 and approved a petition to change places and purposes of use in the CVP.
- **North Delta Water Agency (NDWA).** In 1981, DWR and NDWA executed a contract that ensures that there will be suitable water available in the northern Delta for agriculture and other beneficial uses. Further, a 1998 memorandum of understanding provides that DWR is responsible for any obligation imposed on NDWA to provide water to meet Bay-Delta flow objectives so long as the 1981 contract remains in effect.
- **Delta Protection Act and Area of Origin statutes.** See discussion under Water Rights under subhead "Water Supplies."

PLACEHOLDER Table D-3 Laws, Directives, and Orders Affecting CVP and SWP Operations

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Water Quality

The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB 2006) established water quality objectives for the Delta based on the identified beneficial uses of Delta waters. Those beneficial uses include: Municipal and Domestic Supply; Industrial Service Supply; Industrial Process Supply; Agricultural Supply; Groundwater Recharge; Navigation; Water

Contact Recreation; Non-contact Water Recreation; Shellfish Harvesting; Commercial and Sport Fishing; Warm Freshwater Habitat; Cold Freshwater Habitat; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Estuarine Habitat; Wildlife Habitat; and Rare, Threatened, or Endangered Species.

Surface Water Quality

Generally, water quality in the Delta is affected by hydrologic conditions. The north part of the Delta, which is dominated by Sacramento River water, generally has better water quality than the south part of the Delta, which is dominated by San Joaquin River water. Land use, dredging, and point source and non-point source inputs of pollutants also influence Delta water quality.

The Delta is impaired due to:

- Pesticides (chlorpyrifos, diazinon, group A pesticides, DDT, chlordane, dieldrin, diuron)
- Mercury
- PCBs
- Invasive species
- Localized impairments have been identified for:
    - Pyrethroids in Morrison Creek
    - Electrical conductivity in the southern portion of the Delta
    - Low dissolved oxygen in the vicinity of Stockton and the south Delta
    - Pathogens in the vicinity of Stockton and in Marsh Creek
    - Selenium in the west Delta. (SWRCB. 2010)

Pesticides causing impairment of the Delta are man-made chemicals used to control pests, insects and undesirable vegetation in urban and agricultural landscapes. A fraction of the applied pesticides can enter Delta waterways during rainfall or irrigation events when residual pesticides migrate in stormwater runoff or irrigation return water or migrate with sediment carried in stormwater runoff or irrigation return water and cause unintended toxicity to aquatic life.

High levels of mercury in fish are of concern to people and wildlife that eat Delta fish. Sources of inorganic mercury in the Delta include tributary inflows from upstream watersheds, atmospheric deposition, urban runoff, dredging activities, and municipal and industrial wastewater. Sources of inorganic mercury in the watersheds upstream of the Delta include gold and mercury mine sites, legacy mercury in the stream channel sediments, geothermal springs, atmospheric deposition, urban runoff, and municipal and industrial wastewater. (CVRWQCB. 2010a)

Polychlorinated biphenyls (PCBs) have been classified as probable human carcinogens and the primary exposure is through consumption of PCBs-contaminated fish. PCBs manufacture and distribution in commerce of materials containing detectable PCBs have been banned but large quantities of PCBs remain in use. PCBs have been introduced to the environment through land disposal, accidental spills and leaks, incineration of PCBs or other organic material in the presence of chlorine, pesticide applications, surface coatings such as paints and caulks, and wastewater discharge. In the San Francisco Bay, large quantities of PCBs are present in the water column and sediment. (SFBRWQCB. 2008)

Non-native invasive species in the Delta create a wide range of stresses on native species. They have altered food webs and habitats, they compete with native species for resources, and they directly prey

upon native species. Non-native invasive species have been introduced into the Delta over time via watercraft, fishing gear, live bait, intentionally (either legally or illegally) introduced for recreational or other purposes, or released from aquariums into the environment. (DFG. 2011)

Low dissolved oxygen concentrations may act as a barrier to upstream spawning migration of Chinook salmon and may stress and kill other resident aquatic organisms. The Deep Water Ship Channel is a portion of the San Joaquin River that has been dredged by the U. S. Army Corp of Engineers to allow for the navigation of ocean going cargo vessels between San Francisco Bay and the Port of Stockton. Three main factors contribute to the dissolved oxygen impairment of the Deep Water Ship Channel:

- Loads of oxygen demanding substances from upstream sources that react by numerous chemical, biological, and physical mechanisms to remove dissolved oxygen from the water column in the DWSC.
- DWSC geometry impacts various mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand exerted in the DWSC is increased.
- Reduced flow through the DWSC impacts mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand in the DWSC is increased. (CVRWQCB. 2005)

Other dissolved oxygen impairments in the vicinity of Stockton and the south Delta are most likely due to excess loadings of oxygen demanding substances.

Pathogens and fecal coliforms are a human health concern for drinking water and recreational uses. These bacteria may be introduced to a water body from many sources, including faulty sewer and septic systems, urban runoff, animal wastes, and land use runoff from both developed and undeveloped systems. (USEPA. 2001)

Selenium has been identified as a potential bioaccumulation concern in white sturgeon, and probably green sturgeon, in San Francisco Bay and the western Delta. Selenium mainly originates from natural sources although these sources are often concentrated and redistributed by anthropogenic activities such as agricultural management practices. Fossil fuels such as coal and crude oil are also naturally enriched with selenium. Thus, refining and cracking of crude oil, combustion of fossil fuels and solid wastes, microbial activity, and industrial processes also release selenium to the atmosphere and surface waters. The main sources of selenium to the North San Francisco Bay and the western Delta are industrial and municipal discharges including petroleum refineries, urban and non-urban runoff, erosion and sediment transport within the Bay, flow from Central Valley watersheds through the Delta, and atmospheric deposition. (SFBRWQCB 2011)

Nutrients

The Water Board's Bay-Delta Team, in cooperation with multiple agencies and interested stakeholders, has been evaluating the role of ammonia on the Sacramento-San Joaquin Delta and Suisun Bay ecosystem. Recent studies and analysis indicate ammonia may be impacting Delta species (CVRWQCB 2012a.) Until more definitive studies are completed and the Water Boards implement regulatory controls, it seems prudent to reduce ammonia inputs to the Delta.

Salinity

Salinity enters the Delta from the tides and from return flows from agricultural lands, principally in the San Joaquin Valley. Prior to the construction of today's water supply and flood control facilities, salinities were lower in the winter and spring and higher in the summer and fall. Delta salinity levels are mandated by water quality control regulations. Some evidence indicates that the current (less variable) salinity regime may favor invasive species to the detriment of native species. Small amounts of salt in urban supplies can negatively affect consumer perception and acceptance of tap water. Slightly higher salinities decrease crop yields. Increasing salinity in both agricultural and urban water decreases how the water can be used and, at too high a level, can make the water unusable. While the ecosystem may benefit from more variability in the salinity, the water diversions for agricultural and urban uses rely upon a more constant low level salinity. The bromide in seawater is one contributor to disinfection byproducts in treated drinking water.

Central Valley Salinity Alternatives for Long-Term Sustainability

In the Central Valley, of which almost all of the Delta Region is a part of, the Central Valley Water Board and the State Water Board, working with a stakeholder coalition, are developing a comprehensive salinity and nutrient management plan for the Central Valley. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address problems with salinity and nitrates in the surface waters and ground waters of the Central Valley. The long-term plan developed under CV-SALTS will identify and implement future management measures aimed at the regulation of major sources of salt. As this issue impacts all users (stakeholders) of water within the Delta area, it is important that all stakeholders participate in CV-SALTS to be part of the development and have input on the implementation of salt and nitrate management within the Delta area. In the Central Valley, the only acceptable process to develop the salt and nutrient management plans that are required under state policy (SWRCB. 2009) is through CV-SALTS.

Drinking Water Quality

The Delta provides drinking water to more than 25 million people in the Southern California, Central Coast, and San Francisco Bay regions, and several million people obtain their water supply from the tributaries of the Delta. The tributaries of the Sacramento and San Joaquin Rivers that originate in the Cascades and Sierra Nevada Mountains generally have high quality water; however, as the tributaries flow into lower elevations, they are affected by urban, industrial, and agricultural land uses, natural processes, and a highly managed water supply system.

In general, drinking water systems in the region deliver water to their customers that meets federal and state drinking water standards. Recently the Water Boards completed a draft statewide assessment of community water systems that rely on contaminated groundwater. This draft report identified 21 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (See Table D-4). Arsenic is the most prevalent groundwater contaminant affecting community drinking water wells in the region (see Table D-5). The majority of the affected systems are small water systems which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

PLACEHOLDER Table D-4 Summary of Community Drinking Water Systems in the Sacramento-San Joaquin River Delta Region that Rely on One or More Contaminated Groundwater Well that Exceed a Primary Drinking Water Standard

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

PLACEHOLDER Table D-5 Summary of Contaminants Affecting Community Drinking Water Systems in the Sacramento-San Joaquin River Delta Region

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Groundwater Quality

Groundwater quality in the Delta area is generally good with the following contaminants:

- Arsenic (SWRCB. 2012., USGS. 2010. and USGS. 2011.)
- Localized contamination has been identified:
  - Organic compounds (SWRCB. 2012.)
  - Nitrates (SWRCB. 2012.)
- Hexavalent Chromium (SWRCB. 2011b)

The primary source of arsenic in ground water in the Delta is minerals eroded from the volcanic and granitic rocks of the Sierra Nevada to the east. Geochemical conditions in and near the Delta area are conducive to arsenic dissolution.

Chromium is a metal found in natural deposits of ores containing other elements, mostly as chrome-iron ore. It is also widely present in soil and plants. Recent sampling of drinking water throughout California suggests that hexavalent chromium may occur naturally in groundwater at many locations. Chromium may also enter the environment from human uses. Chromium is used in metal allows such as stainless steel; protective coatings on metal; magnetic tapes, and pigments for paints, cement, paper, rubber, composition floor covering, etc. Elevated levels (above the detection limit of 1 µg/l) of hexavalent chromium have been detected in many active and standby public supply wells along the west or valley floor portion of the Central Valley. (SWRCB. 2011b)

Flood Management

Traditionally, the approach to flood management was to develop narrowly focused flood infrastructure projects. This infrastructure often altered or confined natural watercourses, which reduced the chance of flooding thereby minimizing damage to lives and property. This traditional approach looked at floodwaters primarily as a potential risk to be mitigated, instead of as a natural resource that could provide multiple societal benefits.

Today, water resources and flood planning involves additional demands and challenges, such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness. These additional complexities call for an Integrated Water Management approach, that incorporates natural hydrologic, geomorphic, and ecological processes to reduce flood risk by influencing the cause of the harm, including the probability, extent, or depth of flooding (flood hazard). Some agencies are transitioning to an IWM approach. IWM changes the implementation approach based on the understanding that water resources are an integral component for sustainable ecosystems, economic growth, water supply reliability, public health and safety, and other interrelated elements. Additionally, IWM acknowledges that a broad range of stakeholders might have interests and perspectives that could positively influence planning outcomes. An example of this is the Pinn Brothers Marsh Creek Riparian Restoration Project, which is a collaborative effort among City of Brentwood, Contra Costa County Flood Control and Water Conservation District, Natural Heritage Institute, and the Pinn Brothers, to restore a floodplain and riparian vegetation along a portion of Marsh Creek while maintaining the 100-year flood conveyance capacity.

IWM projects with flood and ecosystem restoration functions could encourage natural groundwater recharge and improve water quality through filtering runoff, controlling erosion and sedimentation and moderating temperature fluctuations. Ecosystem restoration also could provide areas of active- and passive-use recreation, increase open space, and provide scenic value, all of which result in economic and societal benefits.

Land reclamation in the Delta began in the 1850s by construction of levees, resulting in today's complex labyrinth of islands and waterways that are protected from flooding by levees. Many of the Delta levees were initially constructed more than a century ago using primitive materials and equipment. Levee failures occur as a result of large runoff events, extreme high tides, wind-generated waves, earthquakes, land subsidence, sea level rise, or burrowing activities. The consequent flooding of a Delta island can increase the risk of levee failures on adjacent islands.

Risk Characterization

Common flood types in the Delta include stormwater, slow-rise, and coastal flooding. Other possible flood types include tsunami and engineered structure failure. Throughout the Delta, levees were originally constructed from material dredged from adjacent channels, which since have been improved in various places, to hold back river and tidal waters. These levees are subject to damage from rodents, piping, and possibly from foundation movement. These effects could lead to sudden failure at any time of the year. Most of the area's precipitation falls from December through March. Monthly rainfall can come within a single 24-hour period during winter storms. Winter storms bring both high inflows and windy conditions. In combination with annual and daily high tides, this could cause waves to wash over and damage Delta levees, potentially leading to failure. When an island floods, the fetch (the distance along open water or

land over which the wind blows, or the distance waves can traverse unobstructed) is increased to the full width of the island. The waves could cause extensive damage to unprotected interior levee slopes. Other flood types that can occur include debris flow and alluvial fan flooding

Historic Floods

Flood Descriptions

Major floods occur regularly in the Sacramento-San Joaquin Delta Area. Some urban and small-stream flooding occurs in every large storm. Floods during winter storms that cause high water surface elevations and have strong winds have been a common cause of levee failures in the Delta. For example, the flows of the Sacramento River at Rio Vista during winter and early spring are often 30 times the typical late-summer flows. High water in the Delta can overtop levees, as well as increase the hydrostatic pressure on levees and their foundations, causing instability and increasing the risk of failure due to through-levee and/or under-levee seepage.

Delta levee failures have caused more than 170 inundations of islands and tracts since 1900. Levee failures will continue to occur, but the occurrences will be variable, as indicated by many factors. Tides and water-level surges due to low atmospheric pressure will contribute to high water levels at times, which may or may not coincide with periods of high Delta inflow caused by floods. Some inflow floods will have high contributions from the Mokelumne, Cosumnes, San Joaquin, or other smaller tributaries and other contributions will be primarily from the Sacramento River. In addition, isolated sunny-day levee failures (like that on the Upper Jones Tract in June 2004) will occur. These failures could be caused by burrowing activities that compromised the integrity of the levees.

Floods have been recorded in Central Valley for more than 175 years. The most notable flood in the nineteenth century was the "Great Flood" of 1861-1862. Central Valley floods of 1907 and 1909 revised flood management plans of the time and led to development of the San Joaquin River flood management system.

Table D-1 above provides an itemization of islands and tracts flooded since 1900. The data, however, do not identify the date or time of the failure and do not state a cause (e.g., peak flow or high tide).

Damage Reduction Measures

Flood exposure in the Sacramento-San Joaquin Delta Area is widespread throughout the whole region. The Legislature recognized that the Delta is a critically important natural resource for California and the nation. It serves Californians concurrently as both the hub of the California water system and the most valuable estuary and wetland ecosystem on the west coast of North and South America.

Flood exposure identifies who and what is impacted by flooding. Flood exposure provides a limited representation of detailed flood risk. Two levels of flood events are commonly used to characterize flooding:

- **"100-Year Flood"** is a shorthand expression for a flood that has a 1-in-100 probability of occurring in any given year. This can also be expressed as the 1 percent annual chance of, or "1 percent annual chance flood."
- **"500-Year Flood"** has a 1-in-500 (or 0.2 percent) probability of occurring in any given year.

In the Sacramento-San Joaquin Delta Area, nearly half the resident population and $18 billion in assets are exposed to the 500-year flood event. Table D-6 provides a snapshot of people, structures, crops, and infrastructure, and sensitive species exposed to flooding in the area. Figures D-9 and D-10 show the exposure to flood hazard in the Sacramento-San Joaquin Delta Area. Over 100 threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the Sacramento-San Joaquin Delta Area

PLACEHOLDER Table D-6 Sacramento-San Joaquin Delta Area Exposures within the 100-Year and 500-Year Floodplains

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

PLACEHOLDER Figure D-9 Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 100-year Floodplain

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

PLACEHOLDER Figure D-10 Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 500-year Floodplain

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Levee Performance and Risk Studies

Different levees in the Delta were built to different standards. About a third of the levees are project levees and maintained by local reclamation districts with oversight and inspection from the State in conformance with Federal levee policies. The other two-thirds are nonproject levees. The Sacramento District of the USACE and DWR set geometric standards for the crown height and width and for slopes of agricultural levees. The State Hazard Mitigation Plan (HMP) standard was viewed as an intermediate standard with the long-term goal of upgrading to the higher Federal standard of PL 84-99. Levees in compliance with PL 84-99 standards qualify for Federal aid if they are damaged by flooding. Most nonproject Delta levees satisfy HMP standards, but few comply with PL 84-99 standards.

Delta levees are vulnerable to failure from many mechanisms. They can fail during high flood inflow to the Delta, from high tides and wind waves, from earthquakes, and from undetected problems, such as burrowing animals. In addition, the levee system is at risk from future changes, including sea level rise, increases in flood inflows to the Delta due to climate change, land development, land subsidence, and other stressors.

Delta levee improvements performed since the late 1970s have gradually strengthened many miles of levees, making them less vulnerable. The Sacramento and San Joaquin River Flood Control Projects that were completed in the 1960s strengthened project levees. Upstream dams constructed in the 1950s and 1960s attenuated moderate flood flows; however, Delta levees are still vulnerable to failure.

Evaluations of levees for individual Delta islands and tracts are used to periodically plan local levee repairs and upgrades. In addition, several Delta-wide studies of levees have considered the vulnerability

of Delta levees to potential failure. These reports are listed in the references for this regional report. Each of these studies highlighted the relatively high chance of continued Delta levee failures. The Reclamation Districts have individually been funded to produce 5-year plans for upgrading their levees.

Thirty-one local flood management projects or planned improvements are identified in the Sacramento-San Joaquin Delta Area. These projects represent a subset of the work that needs to be completed in the Delta. Potential costs for improvements on Sacramento-San Joaquin Delta levees that would achieve different levels of flood protection range of from $0.1 billion to more than $17 billion. These projects and improvements are summarized in the DWR State Flood Management Plan (SFMP) California's Flood Future: Recommendations for Managing the State's Flood Risk Report (California's Flood Future Report). A list of the local flood management projects can be found in California's Flood Future Report page ___ Table __ .

The local projects have identified costs totaling approximately $1.2 billion. Eight of the local planned projects use an Integrated Water Management (IWM) project approach with a flood management component. Examples of local IWM projects include the Dutch Slough Tidal Marsh Restoration, the Budlisilich Fish Passage Improvements, and the Lower San Joaquin River Flood Bypass.

Accomplishments

In the Sacramento-San Joaquin Delta Area, a number of flood risk management recommendations were accomplished, including the following:

- DWR has created a climate change handbook to help local agencies incorporate climate change into planning activities. In addition, the State of California has developed a statewide climate change adaptation strategy, requested that the National Academy of Science establish an expert panel to report on impacts of sea level rise, and issued interim guidance to agencies on planning for sea level rise in designated coastal and floodplain areas.
- DWR has collaborated with the USACE to produce California's *Flood Future: Recommendations for Managing the State's Flood Risk*, which will help guide local, State, and Federal decisions about policies and financial investments related to improved public safety and flood management throughout California. Information for the California's Flood Future Report was provided by 142 public agencies located in all 58 counties, as well as by State and Federal agencies.
- IRWM planning guidelines were revised to incorporate flood management into the process giving credit for including these flood benefits in Integrated Water Management projects.
- Comments and recommendations from the Flood Risk Management Strategy in the 2009 California Water Plan were used to inform:
  - SFMP California's Flood Future
  - Central Valley Flood Protection Plan
  - IRWM planning
- Water Code Section 8307 links flood liability with local planning decisions. Cities and counties now share flood litigation liability with the State over unreasonably approved new development on previously undeveloped areas.
- Revisions to General Plan will be amended to require that the land use element shall include a statement of the standards of population density and building intensity recommended for the various districts and other territory covered by the plan. The land use element shall identify and annually review those areas covered by the plan that are subject to flooding, as identified by floodplain mapping prepared by FEMA or DWR. The land use element shall do both of the following:

  - Designate in a land use category that provides for timber production those parcels of real property zoned for timberland production pursuant to the California Timberland Productivity Act of 1982 (Chapter 6.7 [commencing with Section 51100] of Part 1 of Division 1 of Title 5).
  - Consider the impact of new growth on military readiness activities carried out on military bases, installations, and operating and training areas, when proposing zoning ordinances or designating land uses covered by the General Plan for land, or other territory adjacent to military facilities, or underlying designated military aviation routes and airspace, per Government Code Section 65302.
- The CVFPP, which was adopted in June 2012, proposes a system wide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control.
- DWR (as required by Water Code Section 9130) and local agencies have analyzed potential flood risks for the State Plan of Flood Control.

Challenges

Flood management in the Sacramento-San Joaquin Delta Area of California has a unique set of challenges, due to the unique nature of the levee system that protects the lands and assets, as well as the multiple uses of the system of waterways for water supply, habitat, and recreational purposes. Typically, flood management agencies in large urban areas tend to be highly organized. Agencies in more rural counties or with low exposure to flooding are often handled by emergency responders or a single contact at the county. This can present a unique set of challenges when developing a project.

Many of these challenges were identified during meetings with local agencies in the Sacramento-San Joaquin Delta Area. These challenges include:

- Inadequate information on floods, including maps and data
- Inconsistent and unreliable funding
- Outdated, and ageing flood infrastructure
- Loss of accreditation of levees
- Economic impact of new 200-year urban level of flood protection standard

Water Planning in the Delta

Delta Plan

The primary responsibility of the Delta Stewardship Council is to develop, adopt, and implement by January 1, 2012, a legally enforceable, comprehensive, long-term management plan for the Sacramento-San Joaquin Delta and the Suisun Marsh—the Delta Plan—that will achieve the coequal goals of "providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem" and does this "in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."

The Delta Stewardship Council is to achieve the following objectives.

- Manage the Delta's water and environmental resources and the water resources of the state over the long term.
- Protect and enhance the unique cultural, recreational, and agricultural values of the Delta as an evolving place.

- Restore the Delta ecosystem, including fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem.
- Promote statewide water conservation, water-use efficiency, and sustainable water use.
- Improve water quality to protect human health and the environment consistent with achieving water-quality objectives in the Delta.
- Improve the water conveyance system and expand statewide water storage.
- Reduce risks to people, property, and state interests in the Delta by effective emergency preparedness, appropriate land uses, and investments in flood protection.
- Establish a new governance structure with the authority, responsibility, accountability, scientific support, and adequate and secure funding to achieve these objectives.

The 2012 Delta Plan is to be a long-term management plan and will be updated every five years. Some elements of the Delta Plan will have regulatory effects. Any plan, project, or program that meets certain criteria will be subject to regulations included in the Delta Plan, and the project proponents must certify consistency with the Delta Plan.

The Delta Plan will include a series of non-regulatory recommendations to be considered by other agencies, the legislature, or the governor. The Delta Plan will present a view of the diversity of the water supply system and its components, including demands for water and how water is currently used, together with the need for an improved Delta ecosystem. The planning time frame is year 2100, using monitoring and adjusting of decisions, "adaptive management," informed by the best available science.

Additional components of the Delta Plan include emergency response plans for each of the Delta counties and for the state and federal water projects, the DPC's Economic Sustainability Plan for the Delta, and the Department of Parks and Recreation's Delta Recreation Plan (released May 2011). A proposed financing plan will also be included in the Delta Plan; legislative action will be required to implement a financing plan.

The Delta Plan will also include regulatory policies and recommendations for actions that will contribute to enhanced water supply reliability, reduce reliance on water exports from the Delta in meeting California's future water supply needs, help restore the Delta ecosystem, reduce flood risk, and improve the collection of water use data and other information that will guide the next Delta Plan update. For the current draft of the Delta Plan, see http://deltacouncil.ca.gov/

The Delta Plan contains 14 regulatory policies and 68 recommendations. The policies are as follows:

- G P1: Detailed Findings to Establish Consistency with the Delta Plan
- WR P1: Reduce Reliance on the Delta
- WR P2: Transparency in Water Contracting
- ER P1: Update Delta Flow Objectives
- ER P2: Restore Habitats at Appropriate Elevations
- ER P3: Protect Opportunities to Restore Habitat
- ER P4: Expand Floodplains and Riparian Habitats in Levee Projects
- ER P5: Avoid Introductions and Habitat Improvements for Nonnative Invasive Species
- DP P1: Locate New Development Wisely
- DP P2: Respect Local Land Use When Siting Water or Flood Facilities or Restoring Habitat
- RR P1: Prioritization of State Investment in Delta Levees and Risk Reduction

- RR P2: Require Flood Protection for Residential Development in Rural Areas
- RR P3: Protect Floodways
- RR P4: Protect Floodplains

Bay Delta Conservation Plan

The BDCP is a HCP/NCCP intended to make significant contributions to the recovery of priority fish and wildlife species while securing reliable water supplies from the Delta for human use. The BDCP is planned to be implemented over a 50-year timeframe according to an adaptive management program. The parties seeking permits pursuant to the BDCP include California Department of Water Resources, Bureau of Reclamation, Metropolitan Water District of Southern California, the Kern County Water Agency, the Santa Clara Valley Water District, Zone 7 Water Agency, Westlands Water District, and the State and Federal Water Contractors Agency (BDCP 2012a). The goal of these parties is to formulate a plan that could ultimately be approved by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service as an HCP under the provisions of Endangered Species Act section 10(a)(1)(B) and as an NCCP by California Department of Fish and Game under Fish and Game Code sections 2800 et seq. and/or the California Endangered Species Act sections 2050 et seq. If the BDCP is successful and meets specific requirements in Water Code section 85320(e), it would become part of the Delta Plan. The DSC has a potential appellate role regarding the inclusion of BDCP in the Delta Plan.

In addition to meeting the conservation needs of priority species, the BCDP aims to contribute to improving water supply reliability by modifying Delta conveyance facilities to create a more natural flow pattern in the Delta and allow for water exports when hydrologic conditions result in the availability of sufficient water, consistent with the requirements of State and federal law and the terms and conditions of SWP and CVP water delivery contracts and other existing applicable agreements.

The BDCP process is considering a range of options for conveying water through or around the Delta:

- Through-Delta Conveyance: Continue to divert water in southern Delta at existing or modified intakes/diversions for SWP and CVP operation.
- Isolated Conveyance: Divert water from the Sacramento River at new intakes/diversions and convey the water to the existing SWP and CVP pumping plants through a pipeline/tunnel.
- Dual Conveyance: Combine through-Delta conveyance and isolated conveyance to allow operation flexibility.

The BDCP process is ongoing. The final BDCP and the related environmental impact report/environmental impact statement are expected to be released in late 2012 (BDCP 2012b).

Bay-Delta Water Quality Control Plan Update

The State Water Resources Control Board's Bay-Delta Water Quality Control Plan (Bay-Delta Plan) identifies beneficial uses of the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives, including control of salinity (caused by saltwater intrusion, municipal discharges, and agricultural drainage) and water projects operations.

The State Water Board is in the process of a phased review and update of the 2006 Water Quality Control Plan for the Bay-Delta. This will include review of potential modifications to current objectives included

in the 2006 Bay-Delta Plan, the potential establishment of new objectives, and modifications to the program of implementation for those objectives. It will also include potential changes to the monitoring and special studies program included in the 2006 Bay-Delta Plan. The Water Quality Control Planning process will not include amendments to water rights and other measures to implement a revised Bay-Delta Plan. A separate Environmental Impact Report will be prepared for these actions In addition, a separate Substitute Environmental Document is being prepared to address updates to the water quality objectives for the protection of southern Delta agricultural beneficial uses; San Joaquin River flow objectives for the protection of fish and wildlife beneficial uses; and the program of implementation for those objectives.

Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

The Central Valley, San Francisco Bay and State Water Boards adopted a Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Strategic Workplan) in July 2008 (SWRCB 2008). The Strategic Workplan was written in response to two SWRCB resolutions to describe the actions they will complete to protect the beneficial uses of water in the Bay-Delta estuary. The work plan activities are divided into nine broad categories:

- Water Quality and Contaminant Control
- Comprehensive Delta Monitoring Program
- Southern Delta Salinity and San Joaquin River Flow Objectives
- Suisun Marsh Objectives
- Comprehensive Review of the Bay-Delta Plan, Water Rights, and Other Requirements to Protect Fish and Wildlife Beneficial Uses and the Public Trust
- Methods of Diversion of the State Water Project and the Central Valley Project
- Water Right Compliance, Enforcement, and Other Activities to Ensure Adequate Flows to Meet Water Quality Objectives
- Water Use Efficiency for Urban and Agricultural Water Users
- Other Actions

Ecosystem Restoration Program

The Ecosystem Restoration Program is a multi-agency effort aimed at improving and increasing aquatic and terrestrial habitats and ecological function in the Delta and its tributaries. Various documents and reports related to these issues can be found online at: http://www.dfg.ca.gov/ERP/reports_docs.asp

Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta

The DFG report "*Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta*" was completed pursuant to Water Code Section 85084.5 to inform water planning and water quality regulatory processes and can be found online at: http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=25987

Central Valley Flood Protection Plan

The Central Valley Flood Protection Act of 2008 directed the California Department of Water Resources to prepare the Central Valley Flood Protection Plan (CVFPP). The CVFPP is a flood management

planning effort that addresses flood risks and ecosystem restoration opportunities in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. It specifically proposes a systemwide approach to flood management for the areas currently protected by facilities of the State Plan of Flood Control (SPFC). Under this approach, California will prioritize investments in flood risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects. The CVFPP was adopted by the Central Valley Flood Control Board on June 29, 2012. It is expected that the CVFPP will be updated every 5 years thereafter.

The CVFPP proposes a systemwide approach to address the following issues:

- Physical improvements in the Sacramento and San Joaquin River basins
- Urban flood protection
- Small community flood protection
- Rural/Agricultural area flood protection
- System improvements
- Non-SPFC levees
- Ecosystem restoration opportunities
- Climate change considerations

The geographic scope of the CVFPP includes only the portions of the Delta covered by the SPFC; approximately two-thirds of Delta levees are not addressed in the CVFPP.

Delta Risk Management Strategy

The DRMS is expected to lead to development of strategies to manage the risk of Delta area levee failure and to improve management of State funding supporting Delta area levee maintenance and improvement. DWR directed the study, which was sponsored by DWR, DFG, and USACE, guided by 20 subject experts from federal, State, local, and private organizations, and performed by about 30 consultants in appropriate fields. The DRMS is in two phases. Phase 1, completed in 2007, identified three risks to Delta area levees (earthquake, high water, and levee and foundation deterioration) and evaluated the consequences in terms of cost, water quality effects, ecosystem effects, and public health and safety. Phase 1 concluded that the annual probability of an island being flooded is less than 1 percent to more than 7 percent, depending on the location. Phase 2 evaluated long-term risk-reduction options for Delta area levees and describes a discrete set of actions that can be taken to reduce the risks and consequences of levee failure. The final Phase 2 report was released in June 2011.

IRWMPs

The IRWM Planning Act, signed by the Governor as part of SB1 in 2008 (California Water Code Sec. 10530 et seq.), provides a general definition of an IRWM plan as well as guidance to DWR as to what IRWM program guidelines must contain. All IRWM plans must discuss if they contribute to the attainment of one or more of the objectives of the CALFED Bay-Delta Program. The regional acceptance process is a component of the IRWM Program Guidelines and is used to evaluate and accept an IRWM region into the IRWM grant program. Acceptance and approval is required before any region can submit an application for IRWM grant funds. Approval has been awarded to the six IRWM regions that touch on the Delta: American River Basin (ARB); East Contra Costa County; Eastern San Joaquin; San Francisco Bay Area; Westside – San Joaquin; and Westside – Yolo/Solano/Napa/Lake/Colusa (see Figure D -11).

PLACEHOLDER Figure D-11 Regional Acceptance Process IRWM Regions, Sacramento-San Joaquin River Delta

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

The Delta region is engaged in IRWM planning through multiple planning regions that empower stakeholders to collaboratively develop integrated solutions and diversified water management portfolios to meet regional water management challenges. The IRWM efforts serve a vital role, in combination with local and statewide planning, to provide for sustainable water use, water quality and environmental functions.

Flood management in the future will require unprecedented integration among traditionally varying agencies that have overlapping and sometimes conflicting goals and objectives. More reliable funding and improved agency alignment are required at all levels. Updated technical and risk management approaches will be needed to protect the public from flooding by assessing risk, as well as by improving flood readiness, making prudent land use decisions, and promoting flood awareness. Project implementation methods could benefit from IWM-based approaches to leverage the limited funding and other flood management resources. In short, future solutions should be aligned with broader watershed-wide goals and objectives and must be crafted in the context of Integrated Water Management.

Integrated Water Management principals are more frequently being applied in flood management planning. An example of an IWM approach in the Sacramento-San Joaquin Delta area is the Lower San Joaquin River Flood Bypass project which will increase flood conveyance capacity through a constrained reach of the San Joaquin River floodway by acquiring easements and fee title to expand Paradise Cut Bypass. The project will also provide floodplain and riparian habitat for sensitive species including riparian brush rabbit, giant garter snake, Sacramento spittail and juvenile Chinook salmon. The project would reduce flood stage in mainstem San Joaquin River between Vernalis and Stockton and reduce the likelihood of levee failure on the San Joaquin River in Lathrop, Manteca and Stockton areas.

Nevertheless, managing floodplain resources and functions in the presence of sensitive species poses additional challenges to water management agencies responsible for operations and maintenance of facilities. For example, routine maintenance of streams and channels by removing vegetation and sediment to maintain design flood capacity might be curtailed to protect habitat for sensitive species. Operation of reservoirs and groundwater recharge facilities might have to be altered to maintain appropriate flows for sensitive species due to the inadvertent establishment of flow and temperature regimes that favor certain species. These practices tend to increase the cost of water management through the loss of flood control or water supply benefits from the facilities, and at the same time, needs increase for alternatives or supplemental projects to remedy the loss. Balancing the multiple objectives of water management with species protection is clearly needed in IWM projects and programs. A list of IWM projects in the Sacramento-San Joaquin Delta area is provided in California's Flood Future Report page ___ Table ___.

The Delta region includes part of seven IRWM plans (American River Basin; East Contra Costa County; Eastern San Joaquin; San Francisco Bay Area; Westside – San Joaquin; Westside – Yolo/Solano/Napa/Lake/Colusa; and Yolo County); however, there are no IRWM plans written

specifically for the Delta region. Some, like the American River Basin Plan, do not mention the Delta by name, but acknowledge that water supply goals and objectives are consistent with the larger statewide goals and objectives outlined by the CALFED Program. Others, like the Yolo County IRWM Plan[1], explicitly tie specific goals, objectives and actions to helping meet the CALFED goal of improving the Delta. These actions include water conservation water quality improvement, and ecosystem restoration. The most common and prevalent themes are water quality and flood control.

The Westside – Yolo/Solano/Napa/Lake Colusa IRWM Plan will list several specific actions for areas in the Delta. Actions include foundational efforts such as monitoring water quality or subsidence, mercury remediation in the Cache Creek system and Yolo Bypass, Clarksburg levee improvement, and Sutter Slough erosion control.

Three other Delta-related issues most common in these IRWM plans are levee system improvement, new or enlarged surface storage, and upstream ecosystem restoration. Land use, and its accompanying water use, is another aspect explored in the IRWM plans. In many cases, the IRWM plans see land use and changes in water use as potentially affecting both quality and flow to the Delta.

The following IRWM Plan updates are currently underway and are expected to be completed at the date shown in Table D-7

PLACEHOLDER Table D-7 Expected Completion for IRWM Plans

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

Some regional projects pertaining to the Delta region are highlighted here.

[Regional project information is still being developed.]

Environmental Stewardship

Climate Change Adaptation

As the science of climate change quickly develops and evolves, local agencies face the challenge of interpreting new information and determining which methods and approaches are appropriate for their planning needs. The Climate Change Handbook for Regional Water Planning (USEPA and DWR 2011) provides an analytical framework for incorporating climate change impacts into a regional and watershed planning process and considers adaptation to climate change. This handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts, and prioritizing these vulnerabilities.

The California Emergency Management Agency (Cal-EMA) and the California Natural Resources Agency (CNRA) have also recently developed a guide to assist local agencies in adapting to climate change (Cal-EMA and CNRA, 2012). Additional tools to supplement these resources include the online Cal-Adapt (http://cal-adapt.org/) tool, which has been designed to provide access to information and climate modeling data produced by the State's scientific and research community, and the Urban Forest Management Plan (UFMP) Toolkit (http://ufmptoolkit.com/). The UFMP toolkit website, sponsored by

the California Department of Forestry and Fire Management, helps local communities manage urban forests to delivery multiple benefits, such as cleaner water, energy conservation and reduced heat-island effects. There are many other reliable resources available on the internet to assist water managers, land-use planners, and local agencies with planning for climate change including the California Climate Change Portal (http://www.climatechange.ca.gov/), the DWR Climate Change website (http://www.water.ca.gov/climatechange/resources.cfm), and the Governor's Office of Planning and Research website (http://www.opr.ca.gov/m_climatechange.php).

The myriad of resources and choices available to managers can seem overwhelming however; there are many 'no-regrets' actions that water managers in the Delta region can take to prepare for climate change, regardless of the magnitude of future warming. These actions often provide multiple co-benefits. For example, wetland restoration not only provides habitat for at-risk species but can help improve water quality, attenuate waves associated with storm surges, and sequester carbon. Other adaptation measures include setback levees, reinforcing or armoring of levees, floodplain restoration, riparian restoration, especially at the toe of levees, and subsidence reversal.

In addition, there are several Resource Management Strategies found in Volume 3 that not only assist in meeting water management objectives but also provide benefits for adapting to climate change including: Agricultural Water Use Efficiency (2); Conveyance – Delta (Ch. 4); System Reoperation (Ch. 6); Matching Water Quality to Use (Ch. 11); Surface Storage – CALFED (Ch. 12); Pollution Prevention (Ch. 17); Agricultural Lands Stewardship (20); Ecosystem Restoration (Ch. 22); Land Use Planning and Management (Ch. 24); Watershed Management (Ch. 27) and; Integrated Flood Management (Ch. 28).

Water managers will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society such as carbon sequestration, pollution remediation, and recreation. Increased cross-sector collaboration between water managers, land use planners and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors. While both adaptation and mitigation are needed to manage risks and are often complementary and overlapping, there may be unintended consequences if efforts are not coordinated (CNRA, 2009).

Climate change will have a significant impact on the timing and magnitude of precipitation and runoff and will contribute to a rise in sea levels. Increased air temperatures could reduce the extent of snow pack in mountainous areas, thereby adding to the portion of watersheds that are available to contribute to direct winter runoff. Decreased snow pack would also reduce spring runoff volumes. Although future precipitation is somewhat uncertain, greater flood magnitudes are anticipated due to more frequent atmospheric river storm events (Dettinger, 2011). These changes could alter the magnitude and frequency of flood events, although specific effects might be difficult to reliably predict. However, the potential for increased frequency and magnitude of floods and a rise in sea level suggest that the enhancement of both structural and nonstructural flood management measures is needed.

Further development in flood-prone areas, population growth, and climate changes will lead to an even greater number of people and more property at risk of flooding in the future. The anticipated changes in climate are projected to have a significant impact on the timing and magnitude of precipitation and runoff, which increases flood risks.

There are numerous planning efforts underway that are looking at the potential impacts of climate change on the Delta region, including the Delta Plan, BDCP, Central Valley Flood Protection Plan, and Ecosystem Restoration Plan.

The Delta Region contains a diverse landscape with different climate zones, making it difficult to find one-size-fits-all adaptation strategies. Water managers and local agencies must work together determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (USEPA and DWR, 2011). However, stationarity can no longer be assumed, so new approaches will likely be required (Milly et.al, 2008). Whatever approach is used, it is necessary for water managers and communities to start implementing adaptation measures sooner than later in order to be prepared for an uncertain future.

Integrated Regional Water Management (IRWM) planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans (DWR 2010). IRWM regions must identify and prioritize their specific vulnerabilities, and identify adaptation strategies that are most appropriate for sub-regions. Planning strategies to address vulnerabilities and adaptation to climate change should be both proactive and adaptive, starting with no-regrets strategies that benefit the region in the present-day while adding future flexibility and resilience under uncertainty.

Ecosystem Services

Presented here is a case study of integrated regional water management that includes enhancement of biological diversity among its goals. One of the aims of the project is to recognize the economic value of the goods and services that nature provides and to incorporate that value into natural resource management decisions. Such recognition includes development of ways to measure the economic value of those services. This can be important information for water managers who normally see only the costs of ecosystem protection and restoration, but not the benefits, in their budgets. The services considered in this project are carbon sequestration for greenhouse gas mitigation, land subsidence reversal and wildlife.

This project constitutes on-the-ground efforts to advance several of the objectives in the implementation plan of Water Plan 2009. In particular, it aims to expand environmental stewardship (objective 5), practice integrated flood management (objective 6) and manage a sustainable California Delta (objective 7).

The project go beyond most watershed management efforts in laying the foundation for establishment of markets to buy and sell units of nature's services, that is, mechanisms for beneficiaries to pay for goods and services they receive. This requires some sort of assessment of the monetary value of the benefits. The desired end product is to put payments in the hands of producers-- that is, resource managers—as an incentive to keep them producing.

Carbon Capture Farming in the Delta

The Sacramento-San Joaquin Delta is a critical natural resource, an important agricultural region, and a major hub for California's water supply. Over the past century, agricultural practices in the Delta have caused the loss of over one million, and perhaps more than two million, acre-feet of peat soils, causing land subsidence down to 20-25 feet below sea level on many islands. Current agricultural practices

continue to remove these soils and, as part of that loss, emit about 5 million tons of carbon dioxide annually—about 1% of California's total emissions (Merrill et al. 2010). Peat soil can generate unusually large amounts of greenhouse gases because it is a natural storehouse of enormous amounts of carbon.

Land subsidence contributes significantly to the risk of failure of the levees that protect the islands. The levees protect farmland and maintain a supply of water to 25 million people and 3 million acres of irrigated farmland outside the Delta. Land subsidence increases the hydraulic stress on levees, making them leakier and more likely to fail, and increases the volume of water that could be taken up by an island in the event of a levee break. In turn, a levee break could allow a pulse of brackish or salt water to invade the Delta and compromise water quality for most uses.

Subsidence reversal should reduce the cost of maintenance of the 1100 miles of levees on the islands and provide better protection for a vast array of infrastructure, including roads, railroads, bridges, airports, ferries, electricity transmission lines, natural gas pipelines, oil and gas production fields, marinas, aqueducts and towns. Two land management options, referred to as carbon capture wetland farms and low carbon agriculture, could reduce soil loss and greenhouse gas emissions, reduce the many risks associated with land subsidence, and provide habitat benefits to the Delta ecosystem.

Carbon capture wetland farms are constructed wetlands operated to maximize retention of atmospheric carbon, mainly in the soil, and minimize the release of other greenhouse gases. Native tule wetlands, in particular, can capture and store carbon at very high rates and, in doing so, build soil that significantly and continuously reverses subsidence

Low carbon agriculture refers to farming practices that reduce GHG emissions and rates of ongoing land subsidence. They could be applied to conventional crops, or in combination with tule wetland farms. These practices could include increasing groundwater levels during the growing and fallow seasons, winter flooding, reduced tillage, soil nutrient management that does not rely on nitrogen-based synthetic fertilizer, and conversion to rice production.

Research on tule wetlands in the Delta shows that a combination of increases in carbon sequestration and prevented soil carbon loss could reduce greenhouse gas emissions by 10 to 35 metric tons of CO2 equivalents per year (Merrill et al. 2010). The reductions could continue to accrue over a period of 50 to 100 years or so, depending on initial subsided land elevations. Soil accretion could average as much as 2.5 to 5.5 inches per year, and would directly improve levee stability through reduced hydrostatic pressure. Restoring wetland habitats could also benefit native wildlife, including waterfowl, the threatened giant garter snake and many other species.

Wetland water management calls for maintaining saturated conditions in more of the soil profile more of the time than in conventional farming. This prolonged soil saturation reduces decomposition rates of plant material and greenhouse gas emissions that result from the decomposition.

A pilot project on Twitchell Island, conducted by US Geological Survey and DWR, provided much of the foundational science about carbon budgets on Delta islands. Originally a study of the potential for subsidence reversal, the project directly measured greenhouse gas fluxes in tule wetlands and adjacent control sites, which were conventionally managed corn fields. Overall effects on greenhouse gas storage and release were driven both by carbon capture in the wetlands and by large greenhouse gas emissions

from corn fields. That is, the conversion of annual cropland to wetlands both sequestered a large amount of carbon dioxide and prevented the greenhouse gas emissions caused by plowing, drying, and fertilizing peat soil.

Growers of tule wetlands could earn revenue from the sale of carbon credits. AB 32, the Global Warming Solutions Act, mandates large reductions in greenhouse gas emissions in California. One likely method to reduce emissions is through a market in carbon offset credits. Economic models are under development to project break-even costs for replacing conventional farmland with wetlands. Preliminary findings are that carbon capture wetlands might become financially viable when carbon prices reach about $20 per metric ton. This break- even price excludes unknown or highly variable factors, such as land acquisition and costs of verification of greenhouse gas credits.

The potential for carbon-capture wetlands and other low-carbon farming methods to provide so many benefits-- wildlife habitat, flood protection and public safety, reliable water quality and supply, greenhouse gas mitigation, jobs and income for farmers—has attracted attention from several quarters. A comprehensive study performed jointly by The Nature Conservancy, Environmental Defense Fund, Wetlands and Water Resources, Inc., and Stillwater Sciences ("Greenhouse gas reduction and environmental benefits in the Sacramento-San Joaquin Delta: advancing carbon-capture wetland farms and exploring potential for low carbon agriculture") in 2011 concluded that the benefits of carbon capture wetland farming are established well enough to prompt the next step, farm-scale demonstration projects. These would involve technical studies to develop protocols to measure carbon offsets, including greenhouse gas fluxes and overall carbon budgets. Studies also would address potential adverse impacts, including contamination from mercury and dissolved organic carbon and the need for mosquito control.

DWR has partnered with TNC and EDF in an effort to locate and fund a larger, 200- to 400-acre site in the Delta for feasibility testing at the farm scale. A demonstration project could examine both the costs and greenhouse gas emissions from a menu of management practices, including winter flooding, low-carbon agriculture, rice production, tule farms, and wetlands designed for waterfowl and waterfowl hunters. Potential partners include Metropolitan Water District, Irvine Ranch Water District, Sacramento Municipal Utility District, Pacific Gas and Electric and the Delta Conservancy.

Meanwhile, DWR has established a 305-acre project to grow tules on Sherman Island to measure carbon budgets and enhance habitat features. Enhancements include provision of open water (without tules) preferred by waterfowl, islands for bird nesting, and introduction of fish for mosquito control. DWR also has constructed a 300-acre rice research project on Twitchell Island to study subsidence reversal, carbon sequestration, effects on methyl mercury and certain agricultural chemicals, and economic feasibility.

Resource Management Strategies

Resources management strategies are detailed in Volume 3 of Update 2013. A number of these strategies will be useful in improving the management of water for use within the Delta as well as tackling other challenges. Table D-8 lists the resource management strategies that appear applicable in the Delta based on regional studies. Several efforts under way may potentially implement a number of these resource management strategies.

PLACEHOLDER Table D-8 Resource Management Strategies and Delta Actions

[Any draft tables, figures, and boxes that are available to accompany this text for the advisory committee draft are included at the end of the regional report.]

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Table D-1 History of Delta and Suisun Marsh Levee Failures and Flooding

Decade	Number of Flooded Islands/Tracts
2001-2010	4
1991-2000	14
1981-1990	22
1971-1980	8
1961-1970	6
1951-1960	11
1941-1950	14
1931-1940	16
1921-1930	3
1911-1920	4

Source: URS/JBA, 2008 and DSC, 2011

Table D-3 Laws, Directives, and Orders Affecting CVP and SWP Operations

Laws, Directives, and Orders	Year	Description
Delta Protection Act	1959	Ensures water is available for in-Delta beneficial uses
North Delta Water Agency	1981	Contract that ensures there will be suitable water in the Northern Delta for agriculture and other beneficial uses.
Coordinated Operating Agreement	1986	Agreement between the State and feds to determine the respective water supplies of the CVP and SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the projects
SWRCB Orders 90-5, 91-1	1990, 1991	Modified Reclamation water rights to incorporate temperature control objectives in the Upper Sacramento River
NMFS BO for Winter-run Chinook Salmon	1992, 1993, 1995, 2009	Established operation to protect winter-run and provided for "incidental taking"
CVPIA	1992	Mandated changes to the CVP particularly for the protection, restoration and enhancement of fish and wildlife
FWS BO for Delta Smelt and Sacramento Splittail	1993, 1994, 1995, 2008	Established operational criteria to protect Delta Smelt
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994, 1995	Agreement and associated SWRCB order to provide for the operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for development of a new Bay-Delta operating agreement (being pursued through CALFED)
Monterey Agreement	1995	Agreement between DWR and SWP contractors to manage contractor operations
SWRCB Revised Water Right Decision 1641	2000	Revised order to provide for operations of the CVP and SWP to protect Delta water quality
CALFED ROD	2000	Presented a long-term plan and strategy designed to fix the Bay-Delta
CVPIA ROD	2001	Implemented provisions of CVPIA including allocating 800,000 acre-feet of CVP yield for environmental purposes
NMFS BO for Spring-run Chinook Salmon and Steelhead	2001, 2002, 2004, 2009	Established criteria for operations to protect spring-run Chinook salmon and steelhead
SWRCB Order 2006-0006	2006	Draft Cease and Desist Order against DWR and Reclamation

Source: Table entries in part are excerpts from Table 1-1 of the June 2004 CVP-OCAP available at: http://www.usbr.gov/mp/cvo/ocapBA.html

Table D-4 Summary of Community Drinking Water Systems in the Sacramento-San Joaquin River Delta Region that Rely on One or More Contaminated Groundwater Well that Exceeds a Primary Drinking Water Standard

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	No. of Affected Community Drinking Water Systems	No. of Affected Community Drinking Water Wells
Small System ≤ 3,300	18	23
Medium System 3,301 - 10,000	1	2
Large System ≥ 10,000	2	2
Total	21	27

Source: Water Boards 2012 Draft Report on "Communities that Rely on Contaminated Groundwater"

Table D-5 Summary of Contaminants affecting Community Drinking Water Systems in the Sacramento-San Joaquin River Delta Region

Principal Contaminant (PC)	Community Drinking Water Systems where PC exceeds the Primary MCL	No. of Community Drinking Water Wells where PC exceeds the Primary MCL
Arsenic	17	22
Nitrate	2	2
Gross alpha particle activity	1	2
Fluoride	1	1
Uranium	1	1

Source: Water Boards 2012 Draft Report on "Communities that Rely on Contaminated Groundwater"

Table D-6 Sacramento-San Joaquin Delta Area Exposures within the 100-Year and 500-Year Floodplains

Segment Exposed	1% (100-year) Floodplain	0.2% (500-year) Floodplain
Population, % total exposed	59,300, 13%	218,100, 47%
Structure and Content Value	$6.1 billion	$18.0 billion
Crop Value	$683 million	$1.0 billion
Tribal Lands (acres)	0	0
Essential Facilities (count)	20	92
High Potential-Loss Facilities (count)	19	47
Lifeline Utilities (count)	4	13
Transportation Facilities (count)	134	251
Department of Defense Facilities (count)	2	2
State and Federal Threatened, Endangered, Listed, and Rare Plants [a]	46	46
State and Federal Threatened, Endangered, Listed, and Rare Animals [a]	61	64

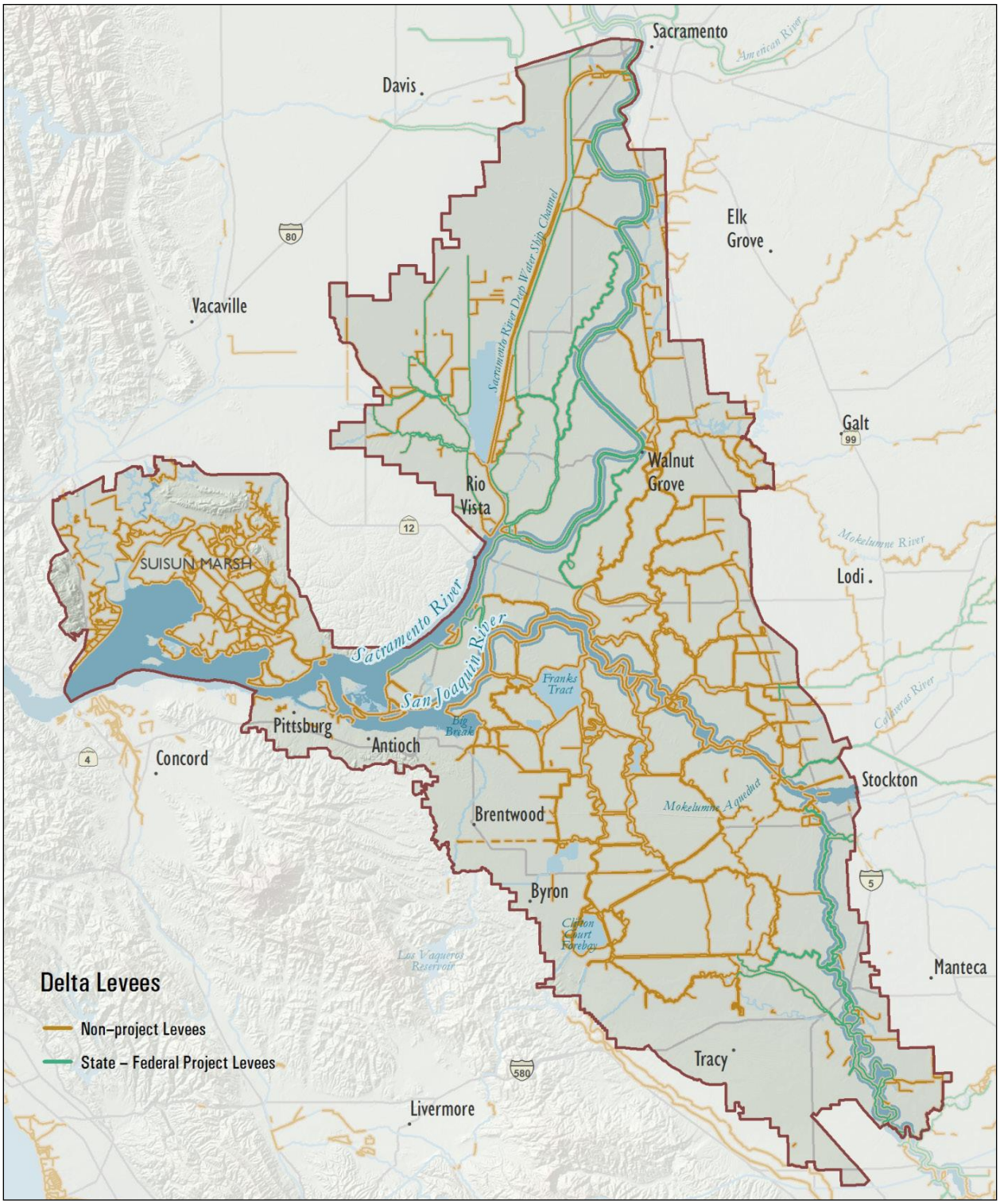
Source: SFMP California's Flood Future Report.

[a] Many Sensitive Species have multiple occurrences throughout the state and some have very large geographic footprints that may overlap more than one analysis region. As a result, a single Sensitive Species could be counted in more than one analysis region. Because of this the reported statewide totals will be less than the sum of the individual analyses regions.

Table D-7 Expected Completion for IRWM Plans

IRWM Region	Expected Completion Date
American River Basin IRWM Plan	January 2013
East Contra Costa County IRWM Plan	December 2012
Eastern San Joaquin IRWM Plan	February 2013
San Francisco Bay IRWM Plan	October 2013
Westside – San Joaquin IRWM Plan	{looking into this}
Westside – Yolo/Solano/Napa/Lake/Colusa IRWM Plan	October 2013

Delta Levees



[This graphic showing levees in the Sacramento-San Joaquin River Delta is being considered for use online, along with other maps of this area.]